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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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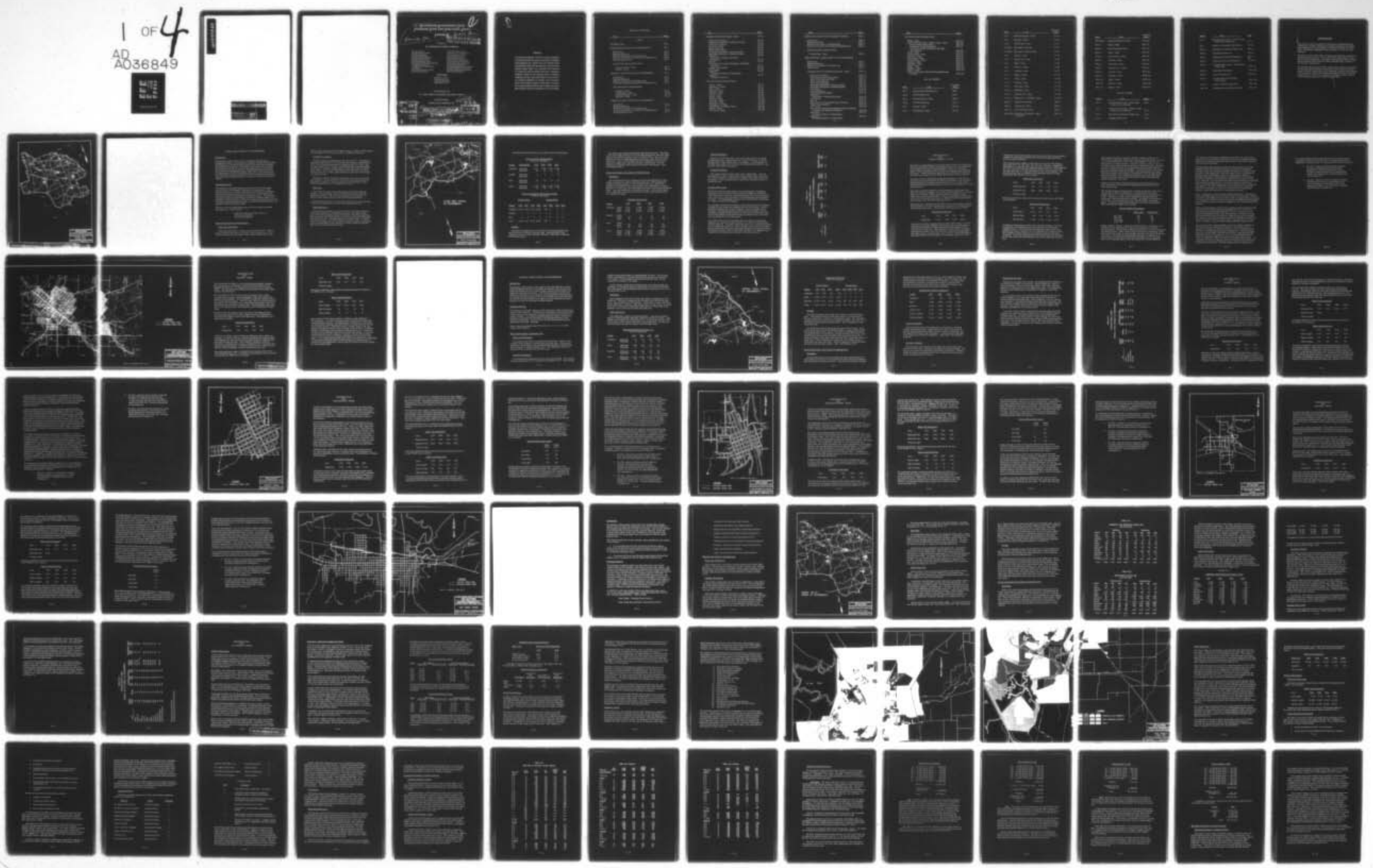

(6) WASTEWATER MANAGEMENT PLAN.

COLORADO RIVER AND TRIBUTARIES, TEXAS.

VOLUME VI. Central Basin Areawide Plan.



Prepared by

THE GOVERNOR'S PLANNING COMMITTEE

Office of the Governor
Texas Water Development Board
Texas Water Quality Board
Texas Water Rights Commission
Texas Parks and Wildlife Department
Railroad Commission of Texas
Texas State Department of Health
Texas State Soil and Water Conservation Board
U. S. Department of the Interior
U. S. Department of Housing and Urban Development
U. S. Environmental Protection Agency
Farmers Home Administration

Lower Colorado River Authority
Colorado River Municipal Water District
Central Colorado River Authority
Upper Colorado River Authority
Capital Area Planning Council
Alamo Area Council of Governments
Central Texas Council of Governments
Concho Valley Council of Governments
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Permian Basin Regional Planning Commission
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Study Management By

U. S. ARMY CORPS OF ENGINEERS, FORT WORTH DISTRICT

Consulting Engineers

TURNER, COLLIE & BRADEN, INC.

(12) 365p.



(21)

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

See also Volume 7, AD-A036 850.

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## PREFACE

The information presented in this volume consists of background and technical data that were used in the formulation of the Wastewater Management Plan, Colorado River and Tributaries, Texas, dated September 1973, which was approved by the Environmental Protection Agency Region VI on 4 December 1973. These data are intended for use by the affected communities in the basin as background material for future planning actions in wastewater management and other water quality fields. For those communities considering application for treatment works construction grants, this information can serve as a data base for the preparation of material required in Sections 201 and 208 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500).

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## INTRODUCTION

This volume of the Colorado River Wastewater Management Study contains the areawide planning documents pertaining to the Central Basin Planning Area and prepared in conjunction with the Colorado River Wastewater Management Plan, Volumes I, II, III, IV, and Summary.

During the course of the Study, the Basin was divided for convenience into three planning areas. The results of the study efforts for the three areas are contained in the Upper Basin Areawide Plan, Central Basin Areawide Plan and Lower Basin Areawide Plan, (Volumes V, VI, and VII, respectively).

This Central Basin Areawide Plan contains those documents prepared for the planning jurisdictions of the Alamo Area Council of Governments, Central Texas Council of Governments, Concho Valley Council of Governments, Middle Rio Grande Development Council, and West Central Texas Council of Governments. The general area covered by this planning document is shown on Plate CB-1.


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

CENTRAL BASIN
PLANNING AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

PLATE: CB-1

# ALAMO AREA COUNCIL OF GOVERNMENTS

## Introduction.

The purpose of this section of the "Colorado River Wastewater Management Study" is to present the areawide plan for the area within the boundaries of the Alamo Area Council of Governments and within the Colorado River Basin. The foremost objective of the areawide plans presented in this section is to recommend the best plan which will satisfy the requirements of the Federal Water Pollution Control Act Amendments of 1972 (hereinafter referred to as PL 92-500) and the waste load allocations as set forth for the Colorado River Basin for each community presently having or in need of a municipal sewerage system.

## Planning Authority.

The planning coordination agency for this study area is the Alamo Area Council of Governments, with offices in San Antonio. The Council consists of a General Assembly and an Executive Committee. The General Assembly reviews and adopts plans and programs and advises the Executive Committee as to general policy. The Executive Committee adopts an annual budget, determines regional plans to be developed, exercises powers of contract, appoints an Executive Director, contracts with member governments, receives and disburses funds, and applies for State and Federal funds.

There are several implementing agencies whose realm lies within the study area. These include:

Edwards Underground Water District
Gillespie County SCD
Kerr County S&WCD

## Physical Description of Planning Area.

### Study Area Delineation.

The Alamo Area COG is located in west central Texas. However, only a portion of the COG is within the Colorado study area. This portion includes all of Gillespie County, approximately half of Kerr

County, and a minor portion of Kendall County, as shown on Plate AA-A. The remainder of this discussion will be confined to this area.

Climatic Description.

The mean annual temperature for the area is 65.5°. The January minimum temperature is 36°, while the July maximum temperature is 95°. The average growing season is approximately 219 days. The average rainfall is 29.9 inches, and the mean annual net evaporation is 45 inches. During a drought period such as the one that occurred from 1950 to 1956, the net evaporation can be expected to increase 15-20 percent over normal, while rainfall may decrease to 20-25 percent below normal.

During the summer months the prevailing wind is from the south and southeast. During the winter months the prevailing wind has no prominent prevalence. The mean annual relative humidity varies from 77 percent at 6 a.m. to 44 percent at 6 p.m.

Hydrology.

The study area lies in the northeastern sector of the Edwards Plateau. The topography consists of plateau and hills, broken by spring-fed streams. The area slopes gently to the southeast. It drains to the Colorado River by way of the Pedernales River.

The Pedernales River is the only major tributary in the study area. There are no major lakes or reservoirs regulating the flow.

Water Resources.

The study area contains two primary and two secondary aquifers. The primary aquifers, the Edwards Limestone and Trinity Sands, serve all but the northeast portion of the area. The Ellenburger-San Saba Limestone and Hickory Sands serve the western and southeastern portions of the area. Although there are no major reservoirs in the area at the present time, the San Saba Reservoir has been proposed as a future impoundment at the confluence of Brady Creek with the San Saba River in western San Saba County.


ALAMO AREA COUNCIL OF GOVERNMENTS

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

AACOG STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 16 MI. PLATE: AA-A

Present and projected water use is shown in the following table:

Projected Water Requirements
(Acre-ft. per year)

| County | Requirement | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|
| Gillespie | Municipal | 1,631 | 1,930 | 2,165 | 2,817 |
| | Industrial | 25 | 28 | 29 | 37 |
| Kendall | Municipal | 5 | 6 | 7 | 10 |
| | Industrial | - | - | - | - |
| Kerr | Municipal | 16 | 16 | 17 | 19 |
| | Industrial | - | - | - | - |
| Total | Municipal | 1,652 | 1,952 | 2,189 | 2,846 |
| | Industrial | 25 | 28 | 29 | 37 |

Projected Irrigation Water Requirements
(Acre-ft. per year)

| | Surface Water | | | | Ground Water | | | |
|---|---|---|---|---|---|---|---|---|
| County | 1969 | 1980 | 1990 | 2020 | 1969 | 1980 | 1990 | 2020 |
| Gillespie | 1,019 | 1,341 | 1,636 | 3,222 | 340 | 0 | 0 | 0 |
| Kendall | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kerr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1,024 | 1,341 | 1,636 | 3,222 | 340 | 0 | 0 | 0 |

Geology.

The surface geology of the area consists of several geologic ages. Most of the area is of the Cretaceous age. Some portions of the northern sector are of the Devonian, Silurian, Ordovician, Cambrian, and Paleozoic ages.

The study area contains two general land resource areas. The north central and southern sections lie in the Edwards Plateau, while the south central and northern portions lie in the Central Basin. The soils of the Edwards Plateau are generally dark, calcareous, stony clays and some clay loams. Those of the Central Basin are reddish-brown to brown, neutral to slightly acid, gravelly and stony, sandy loams. Natural vegetation is generally short grasses intermixed with junipers, oaks, and mesquite trees.

## Social and Economic Description of Planning Area.

### Population.

The following table gives existing and projected population for each county or portion of a county within the study area. The existing and projected urban population is also included in the table, with urban population consisting of those communities with a population of 2,500 or greater. For this area, the urban population center is the Fredericksburg area. The rural population is expected to decline. The overall population is expected to increase due to interest in the Fredericksburg area as a retirement center.

Population Projections

| County | | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|
| Gillespie | Urban | 5,326 | 6,500 | 7,280 | 9,540 |
| | Rural | 5,216 | 4,590 | 4,410 | 3,250 |
| | Total | 10,542 | 11,090 | 11,690 | 12,970 |
| Kendall | Urban | - | - | - | - |
| | Rural | 67 | 70 | 70 | 80 |
| | Total | 67 | 70 | 70 | 80 |
| Kerr | Urban | - | - | - | - |
| | Rural | 183 | 180 | 180 | 180 |
| | Total | 183 | 180 | 180 | 180 |
| Total | Urban | 5,326 | 6,500 | 7,280 | 9,540 |
| | Rural | 5,466 | 4,840 | 4,660 | 3,510 |
| | Total | 10,792 | 11,340 | 11,940 | 13,050 |

Land Use Analysis.

Nearly all of the land in the study area is agricultural, ranching, and generally open, undeveloped land. Much of this land is used for raising cattle, sheep, goats, hogs, and poultry. A small amount of the land in the study area contains areas utilized for residential, commercial, and industrial purposes.

Economic Analysis.

The major economic base for this area is agriculture. Over 90 percent of the income is from cattle, sheep, goats, hogs, and poultry. The main businesses are agricultural-related, and peanut and turkey processers. The area population is expected to increase by about 18 percent by 2020.

## Existing Waste Loads

Within the area plan which follows, the projected waste loadings as furnished by the Texas Water Quality Board (TWQB) are presented. Those projections, based on census populations and not service populations, were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in Volume II, Basin Plan Appendix.

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream.

Very little of the available sampling data was consistent; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in the loadings and estimates in the following table.

## TABLE AA-1

## EXISTING WASTE LOADS

## ALAMO AREA COUNCIL OF GOVERNMENTS

| City | Estimated Population Served | Discharge | Estimated Influent Loading | | | Estimated Treatment Reduction | Estimated Effluent Loading | |
|---|---|---|---|---|---|---|---|---|
| | | | Flow mgd | BOD lb./day | TSS lb./day | | BOD lb./day | TSS lb./day |
| FREDERICKSBURG | 4,400 | Yes | 1.1 | 5,780 | 2,835 | 85% / 85% | 870 | 420 |

## AREAWIDE PLAN
## FOR
## FREDERICKSBURG, TEXAS

The City of Fredericksburg is an incorporated General law municipality located in the eastern portion of Gillespie County at the intersection of U.S. Highways 290 and 87 approximately 77 miles west of Austin, Texas. The incorporated area of the City encompasses approximately 280 acres. Fredericksburg is the county seat of Gillespie County and is within the jurisdiction of the Alamo Area Council of Governments.

The City of Fredericksburg has moderate topographic relief with an elevation decrease of about 80 feet from the northwest to the southeast. Fredericksburg is drained by Baron Creek and Town Creek, both of which flow through the central portion of the City in a northwest to southeast direction.

The City is primarily underlain by the Pedernales sandy loam soils. This soil type has a slightly acid surface, approximately 10 to 15 inches thick, over a friable to firm, porous, sandy clay which becomes calcareous below about three feet. Surface permeabilities range from 0.63 to 2.0 inches per hour; however, septic tanks have severe limitations in these soils due to the underlying clays.

Population data, developed by the TWQB for use in this study, indicate that a moderate increase in population is expected for Fredericksburg over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 5,326 | 6,500 | 7,280 | 9,540 |

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural; however, the City also has a turkey-processing plant, two locker plants, a trailer plant, and a recently constructed hospital. Since the City has become known as a retirement center due to the

climate and scenic beauty of the area, the influx of these new permanent residents is expected to stimulate the economy through demand for service-related industries.

The municipal water supply is drawn from seven wells with pumping capacities of 75, 75, 125, 500, 750, 900 and 1,000 gpm. Storage for the system is provided by three ground storage reservoirs with capacities of 0.30, 0.50, and 0.185 mg, and three elevated storage reservoirs, two with capacities of 1.0 mg each and one of 0.10 mg capacity. The projected water use, a reflection of the population trend, has been projected by the TWQB to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 1.05 | 1.37 | 1.58 | 2.22 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow (mgd): | 0.45 | 0.55 | 0.62 | 0.81 |
| BOD (lb/day): | 900 | 1,170 | 1,310 | 1,810 |
| TSS (lb/day): | 1,060 | 1,360 | 1,600 | 2,190 |

In addition to the domestic waste load on present facilities is the discharge from a large poultry-processing operation and two small slaughter houses. The flow from these industrial sources has been estimated in earlier reports to be of a magnitude of 0.5 mgd or more. The strengths of these wastes are as would be expected from such operations. The total combined projected waste flows would therefore be the sum of the projected municipal load and the industrial contribution.

The existing wastewater collection system is shown on Plate AA-1. The system is apparently adequate for general collection needs, and there are no significant areas of town where septic tanks are still the primary means of sewage disposal. There is, however, a major collector serving the City which has been analyzed by measurement and calculation in earlier reports and found to be inadequate for the present load and heavily surcharged during wet weather. To provide relief to the system, the major collector should be paralleled with the proposed line shown. The other proposed lines shown are presented to serve the anticipated population growth. The estimated total project cost, including engineering and contingencies for the relief sewer is $174,200 and for the system extensions is $93,400.

Under current Federal funding regulations, the local contribution toward these improvements would be approximately 25 percent of the total project costs.

The existing sewage treatment plant is located on Barons Creek southeast of town as shown on Plate AA-1. Constructed in 1966 with a design capacity of 1.0 mgd, the plant presently serves a population of 4,400. The plant is of the contact-stabilization type and has been maintained in excellent physical condition. It consists of a barminutor, bar screen, contact stabilization unit, Parshall flume, and holding ponds. Available sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent-Effluent Data (mg/l)

| | TSDH (1972) | TWQB (1972) |
|---|---|---|
| Raw BOD | 180 | 630 |
| Raw TSS | 130 | 309 |
| Final BOD | 17 | 20 |
| Final TSS | 19 | 14 |

Sludge disposal consists of using the dried material as fertilizers, and effluent from the holding pond is used for the irrigation of Coastal Bermuda grass. Excess flow during wet periods of the year is discharged into Barons Creek. Other waste sources in the area contributing to the plant include the turkey-processing plant and two locker plants mentioned previously. The turkey-processing plant pretreats its effluent by removal of most solids and as much blood as possible before releasing them to the municipal plant. Some discussion has occurred between

local officials and interests considering construction of a hog-processing plant in the City which would add to the facility's influent; however, interest in the plant has apparently waned, and no significant industrial load increase is expected.

Although the present secondary facility has the capacity to treat the domestic effluent produced by the projected population through the planning period, the combined municipal and industrial loading is now in excess of the design load. Previous reports have recommended a parallel contact-stabilization unit of 1.0 mgd capacity; however, population and waste load projections accomplished for this study do not justify construction of a facility of that hydraulic capacity at this time. Although it is realized that the industrial effluent has an extremely high biological oxygen demand, it is felt the expansion should be a process-selection-type design rather than a design based on volumetric equivalence. The other alternative to process design is significant industrial pretreatment to reduce all contribution to an equivalent domestic waste and treatment by conventional processes.

Since, according to current Federal funding regulations, contributing waste-producing industries must share in the cost of facilities construction and it is not within the scope of this study to suggest design processes, it is assumed the City will work out all necessary administrative arrangements and will provide a solution acceptable to local, State and Federal agencies.

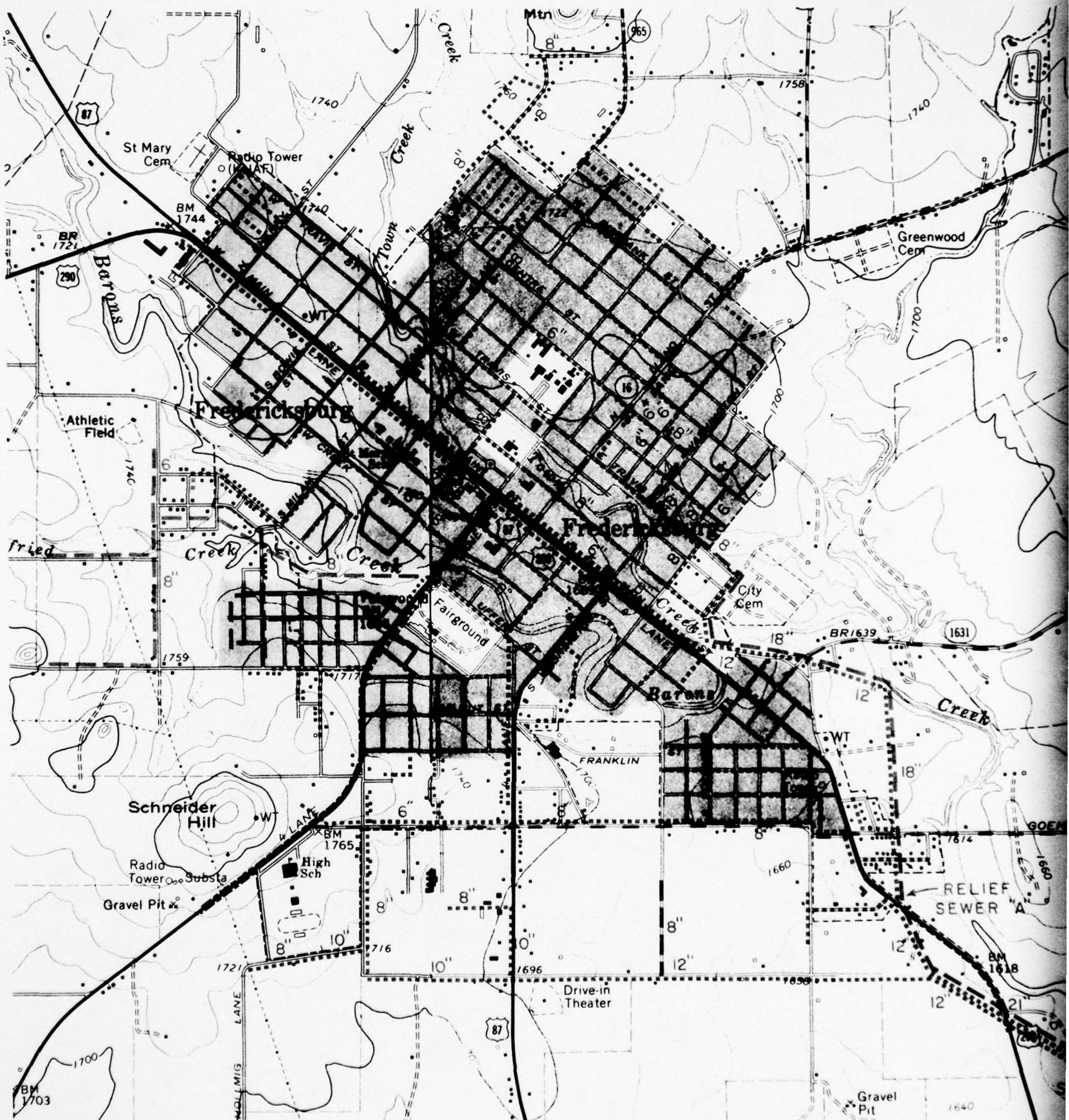
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and "the best practicable waste treatment techology" by 1983. According to the present interpretation of this law, land disposal of effluent by irrigation as practiced by the City meets all requirements of the law when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface water or ground water resources either as runoff, or by percolation without adequate treatment time.

At the present time, approximately 60 acres are under irrigation by the City for about 6 months out of the year. The capital cost for expansion of existing secondary facilities by 1977 is estimated to be $358,500, including engineering and contingencies. Field investigations have revealed that, through local farmers, approximately 200 additional acres are available for use. It is recommended the City enter into agreement with these farmers and initiate year-round irrigation practice by 1983 to be in full compliance with the law. The equipment costs for an additional 200 acres of spray area by 1983 is estimated to be $282,000, including engineering and contingencies.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Fredericksburg wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $205,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $174,000, including engineering and contingencies.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Barons
Town
Creek
Greenwood
Cem
Fredericksburg
Athletic
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Creek
Fairground
City
Cem
BR 1639
Barons
Creek
WT
FRANKLIN
Schneider
Hill
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1618
Drive-in
Theater
BM
1703
Gravel
Pit

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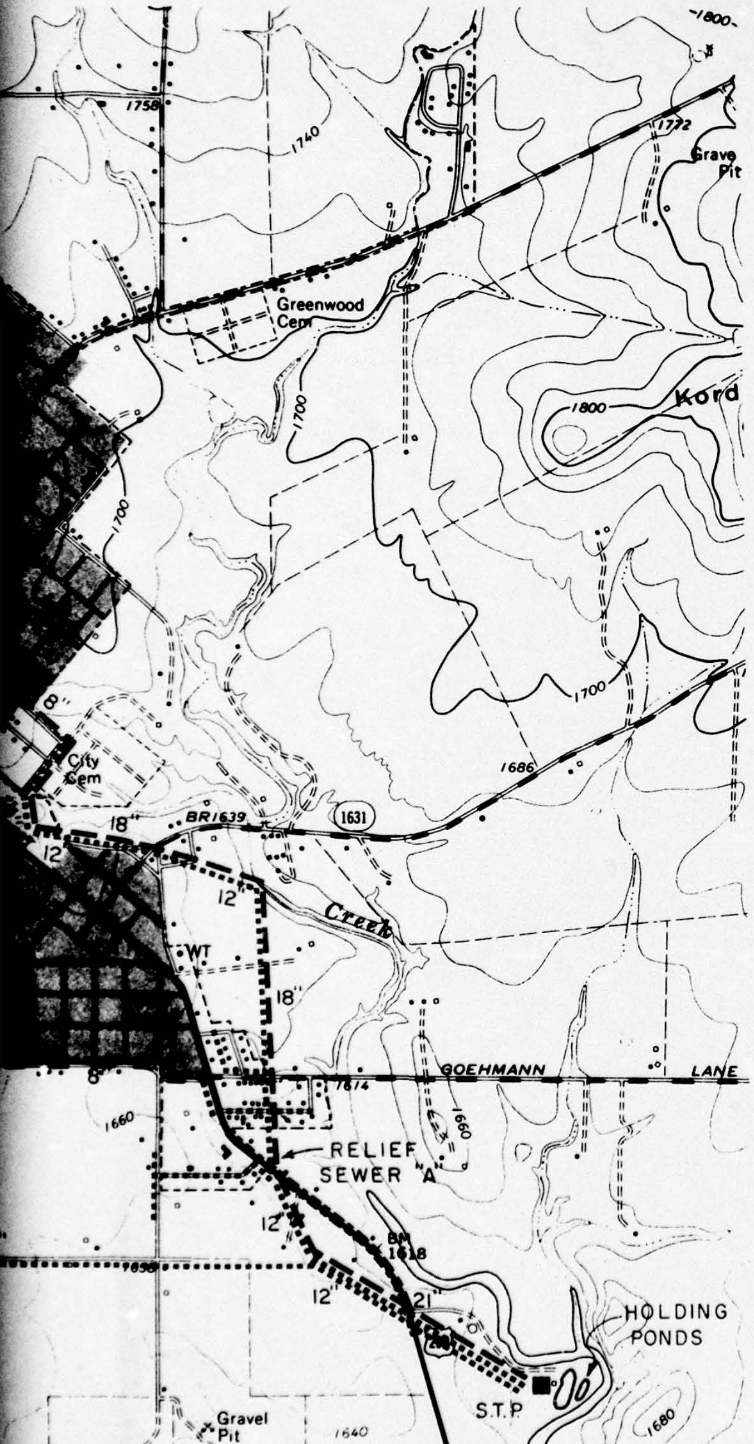



## LEGEND

............ EXISTING SEWER LINES

– – – – PROPOSED SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

| |
|---|
| U.S. ARMY ENGINEER DISTRICT, FORT WORTH<br>CORPS OF ENGINEERS<br>FORT WORTH, TEXAS |
| WASTEWATER MANAGEMENT STUDY<br>COLORADO RIVER & TRIBUTARIES, TEXAS |
| FREDERICKSBURG, TEXAS |
| TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR |
| SCALE: 1" = 1000'     PLATE AA-1 |

## AREAWIDE PLAN
## FOR
## HARPER, TEXAS

The Community of Harper is an incorporated municipality located in the western portion of Gillespie County at the intersection of U.S. Highway 290 and F.M. 783 approximately 100 miles west of Austin, Texas. The Community lies within the jurisdiction of the Alamo Area Council of Governments.

The Community is situated in the valley of Roger's Draw, which provides local drainage, and the topography of the area slopes moderately to the southeast. The Community is primarily underlain by the Frio-Krum soil association. This soil type, which is characteristic of the nearly-level to sloping soils of bottomlands and valleys, has fairly deep calcareous clays and cracking clays. Permeabilities range from 0.2 to 0.63 inch per hour, which imposes severe limitations on septic tanks.

Population data developed by the Texas Water Development Board for use in this study indicate that a slight decrease in population is anticipated for Harper over the next fifty years. The population estimates are as follows:

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 383 | 340 | 320 | 240 |

Land use for Harper, typical of that encountered in other small communities, is characterized by scattered residential development and a concentration of a few commercial and public facilities along the highway which bisects the town. The economy is primarily based on agriculture, although there is some contribution from local gravel and granite mining operations. Population growth is not anticipated due to the lack of any developable resource and economic activity.

The municipal water supply is obtained from a ground water source. The anticipated water use, a reflection of the population trend, has been projected by the TWQB to be as follows:

**Water Use Projections***

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.03 | 0.03 | 0.03 | 0.02 |

*Flows in mgd

Municipal wastewater return flows have been projected for Harper by the TWQB to be as follows:

**Waste Load Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd: | 0.03 | 0.03 | 0.03 | 0.02 |
| BOD in lb/day: | 65 | 61 | 58 | 46 |
| TSS in lb/day: | 77 | 71 | 70 | 55 |

Septic tanks are the primary means of sanitary sewage disposal in the community. A review of available maps indicates that Harper has a light population density. Although Harper is underlain by soils which are classified as imposing severe limitations on septic tanks by the Soil Conservation Service, actual performance of septic tanks in the community will depend on factors such as length of the tile field, residential density, and amount of gravel placed around the drain tile. As long as no severe local problems result from utilizing septic tanks, it is recommended that their use be continued. However, should local problems occur in such severity as to require abandonment of this means of disposal, it is recommended that the septic tanks be replaced by a conventional collection and treatment system which will meet the requirements of current laws and regulations, once an absolute need for such replacement has been demonstrated.

## CENTRAL TEXAS COUNCIL OF GOVERNMENTS

### Introduction.

The purpose of this section of the report on the "Colorado River Wastewater Management Study" is to present the areawide plan for the area within the boundaries of the Central Texas Council of Governments and within the Colorado River Basin. The foremost objective of the areawide plans presented in this section is to recommend the best plan which will satisfy the requirements of PL 92-500 and the waste load allocations as set forth for the Colorado River Basin for each community presently having or in need of a municipal sewerage system.

### Planning Authority.

The planning coordination agency for this study area is the Central Texas Council of Governments. The Executive Committee is the governing body of the Council and is responsible for general policies and programs and control of funds. The General Assembly approves bylaws, gives policy direction to the Executive Committee, and appoints members to the Executive Committee. There are also several implementing agencies within this study area, including:

Water Control and Improvement Districts Nos. 1, 2, 3, 4, 5, and 6
Central Texas S&WCD.

### Physical Description of Planning Area.

#### Study Area Delineation.

The Central Texas COG is located in Central Texas. However, only a portion of the Council is located within the study area. This portion includes all of San Saba County and approximately half of Lampasas and Mills Counties, as shown on Plate CT-A. The remainder of this discussion will be concerned only with this area.

#### Climatic Description.

The mean annual temperature for the study area is 65°F. The January minimum temperature is 33° and the July maximum is 96°. The average

length of the growing season is approximately 227 days. The average annual precipitation is 28 inches and the mean annual net evaporation is 50 inches. In the drought period between 1950 and 1956, the net evaporation increased to 60 inches.

In the summer months the prevailing winds are from the south and southeast, but during the winter months there is no prevalent direction. The mean annual relative humidity varies from 79 percent at 6 a. m. to 45 percent at 6 p. m.

Hydrology.

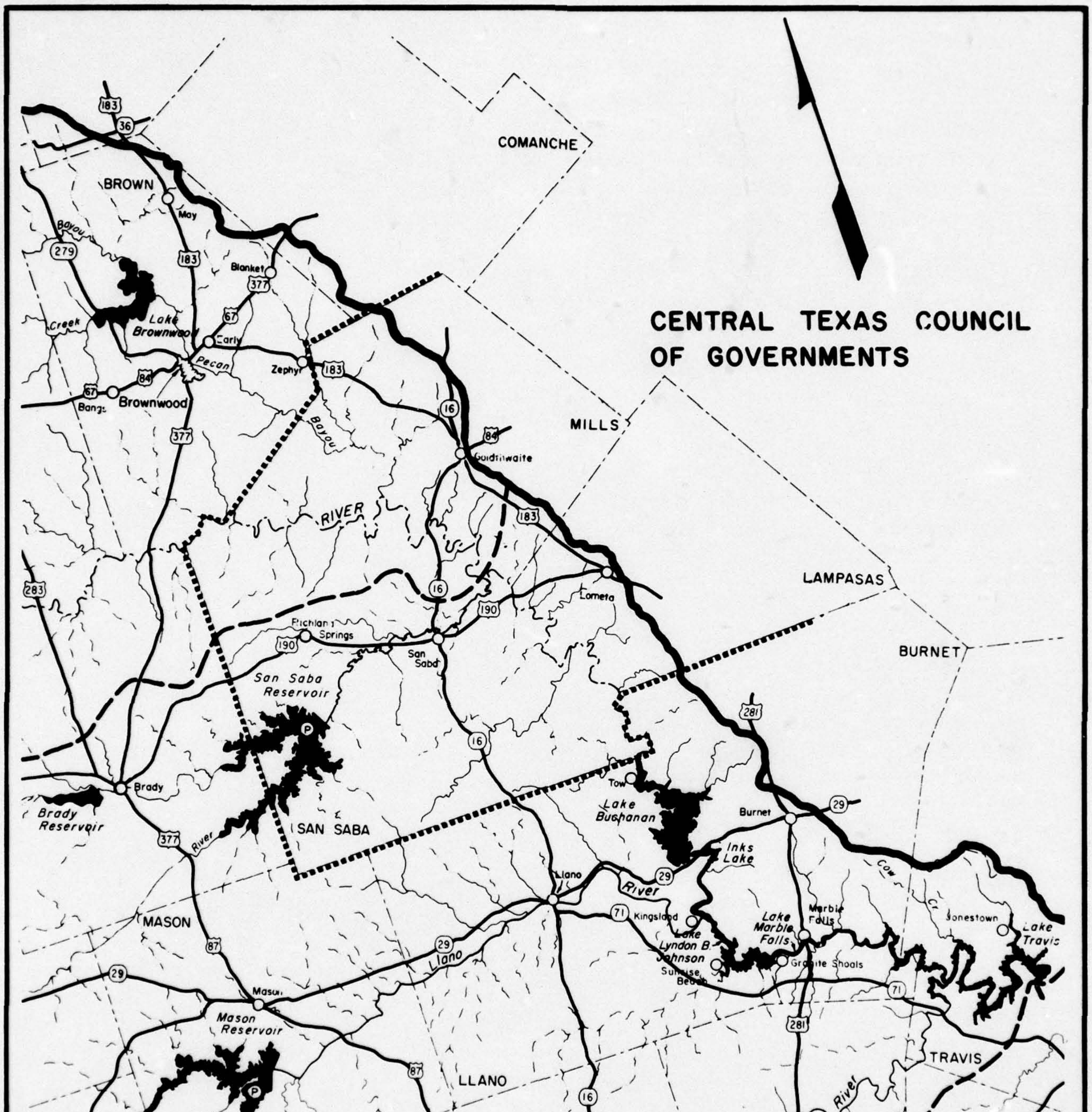
The topography of the area is hilly and rolling, sloping gently to the southeast. The area is drained by the Colorado River and the San Saba River, which empties into the Colorado. There are no major reservoirs in the study area. However, Lake Brownwood in Brown County and Brady Reservoir in McCulloch County have some effect on stream flow in the San Saba and Colorado Rivers within the study area.

Water Resources.

The study area contains no primary aquifers. The only secondary aquifer is the Ellenburger-San Saba Limestone and Hickory Sands. This aquifer serves nearly all of the study area. As stated previously, there are no major surface water reservoirs in the study area. Present and projected water use data are shown in the following tables:

Municipal and Industrial Water Use
(Acre-ft. per year)

| County | | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|
| Lampasas | Municipal | 91 | 951 | 920 | 736 |
| | Industrial | 0 | 0 | 0 | 0 |
| Mills | Municipal | 694 | 692 | 667 | 524 |
| | Industrial | 0 | 0 | 0 | 0 |
| San Saba | Municipal | 1,047 | 901 | 710 | 321 |
| | Industrial | 20 | 22 | 22 | 22 |
| Total | Municipal | 1,832 | 2,544 | 2,297 | 1,581 |
| | Industrial | 20 | 22 | 22 | 22 |




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

CTCOG STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 16 MI. PLATE: CT-A

## Irrigational Water Use
(Acre-ft. per year)

| County | Surface Water 1970 | 1980 | 1990 | 2020 | Ground Water 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|---|---|---|
| Lampasas | 416 | 428 | 436 | 608 | 16 | 0 | 0 | 0 |
| Mills | 4,052 | 3,777 | 3,534 | 3,534 | 0 | 0 | 0 | 0 |
| San Saba | 4,979 | 7,091 | 9,009 | 9,310 | 585 | 617 | 624 | 520 |
| Total | 9,447 | 11,296 | 12,979 | 13,452 | 601 | 617 | 624 | 520 |

### Geology.

The surface geology of the study area consists of several geologic ages. The southern portion of San Saba County is of the Devonian, Silurian, Ordovician, Cambrian, and Paleozoic ages. The remainder of San Saba County and portions of Lampasas and Mills Counties are of the Pennsylvanian and Mississippian ages. The remainder is of the Cretaceous age.

The study area contains three general land resource areas. Most of San Saba County lies in the Edwards Plateau. Most of Mills County lies in the Grande Prairie region. The soils of the Edwards Plateau are generally dark, calcareous stony clays and some clay loams. The North Central Prairies have reddish-brown to grayish-brown soils, neutral to slightly acid sandy loams and clay loams, with some areas of stony soils. The Grande Prairie region soils are reddish-brown to dark-gray clay loams and clays. Natural vegetation is generally short grasses intermixed with junipers, oaks, and mesquite trees.

## Social and Economic Description of Planning Area.

### Population.

The following table presents existing and projected populations for each county or portion of a county within the study area as developed by the Texas Water Development Board. The table also presents existing

and projected urban population for the area, which consists of those communities with a population of 2,500 or greater. For this study area, the urban population consists of the populace of San Saba. As can be seen, the population of San Saba is expected to decline to 2,070 by 1980. Overall, the population of the study area is expected to decline, with both urban and rural populations expected to decline.

Existing and Projected Population

| County | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Lampasas | 1,043 | 950 | 920 | 740 |
| Mills | 3,100 | 2,640 | 2,320 | 1,400 |
| San Saba | 5,540 | 4,400 | 3,500 | 1,700 |
| TOTAL COG | 9,683 | 7,990 | 6,740 | 3,840 |
| TOTAL URBAN | 2,555 | 2,070 | 1,660 | 830 |
| TOTAL RURAL | 7,128 | 5,920 | 5,080 | 3,010 |

Land Use Analysis.

Nearly all of the land in the study area is agricultural, ranching, mining, and generally open, undeveloped land. Much of this land is used for raising livestock, poultry, pecans, peanuts, and sheep, and for extraction of stone, sand, and gravel. A small amount of the land in the study area is used for residential, commercial, and industrial purposes.

Economic Analysis.

The economic resource base of the study area is agriculture and agricultural industries, with minor emphasis on stone processing. The area is not expected to experience any growth in the future. The projected decrease in population would seem to indicate that the area will decline economically in the future.

## Existing Waste Loads.

Within each area plan which follows, the projected waste loadings as furnished by the TWQB are presented. Those projections, based on census populations and not service populations, were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in Volume II, Basin Plan Appendix.

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream.

Very little of the available sampling data was consistent; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in many of the loadings and estimates presented in the following table.

## TABLE CT-1

## EXISTING WASTE LOADS

## CENTRAL TEXAS COUNCIL OF GOVERNMENTS

| City | Estimated Population Served | Discharge | Estimated Influent Loading: Flow mgd | Estimated Influent Loading: BOD lb./day | Estimated Influent Loading: TSS lb./day | Estimated Treatment Reduction | Estimated Effluent Loading: BOD lb./day | Estimated Effluent Loading: TSS lb./day |
|---|---|---|---|---|---|---|---|---|
| LOMETA | 633 | No System | 0.05 | 108 | 126 | – | – | – |
| GOLDTHWAITE | 1,400 | No | 0.17 | 227 | 262 | 56% / 19% | 100 | 210 |
| RICHLAND SPRINGS | 700 | Yes | 0.06 | 55 | 50 | 73% / –10% | 15 | 55 |
| SAN SABA | 2,700 | No | 0.23 | 459 | 540 | 71% / 57% | 130 | 230 |

AREAWIDE PLAN
FOR
LOMETA, TEXAS

The City of Lometa, an incorporated city-owned municipality, is located in the northwestern portion of Lampasas County at the intersection of U.S. Highways 183 and 190 approximately eighty-five miles north of Austin, Texas. The incorporated area of the City encompasses about 560 acres and lies within the jurisdiction of the Central Texas Council of Governments.

Lometa has moderate topographic relief with elevations decreasing approximately sixty feet in a northeastern to southwestern direction. The City is drained by Kirby Creek, which flows in a north-south direction along the western city limits.

Lometa is entirely underlain by Tarrant-Brackett stony soils. These soils have a calcareous, clay loam surface, generally 3 to 8 inches thick, with numerous fragments of limestone. The surface is underlain by a friable, granular, calcareous clay containing numerous large limestone fragments and discontinuous strata, over chalky marl with interbedded limestone at depths of 8 to 15 inches beneath the surface. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks and sewage lagoons both have severe limitations due to the shallow depth of the bedrock.

Population data developed by the Texas Water Development Board for use in this study indicate that a slight decrease in population is expected for Lometa over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
| --- | --- | --- | --- | --- |
| Population: | 633 | 580 | 560 | 450 |

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major throughfares in the central areas of the City. The economy is almost solely based on ranching with no known industrial contribution. Accessible by U.S. Highways 183 and

190, the City is served by the Atchison, Topeka and Santa Fe Railroad. Population growth is not anticipated due to the lack of adequate economic activity or resource availability.

The municipal water supply is obtained solely from ground water sources. The water is drawn by seven wells with a total pumping capacity of 0.092 mgd, and is stored in two elevated storage tanks with capacities of 0.11 mg and 0.08 mg. The projected water use, a reflection of the population trend, has been projected by the Texas Water Development Board to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.05 | 0.06 | 0.06 | 0.05 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by TWQB to be as follows:

Waste Load Projection

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd: | 0.05 | 0.05 | 0.05 | 0.04 |
| BOD in lb/day: | 110 | 100 | 100 | 90 |
| TSS in lb/day: | 130 | 120 | 120 | 100 |

The City currently has no existing municipal wastewater collection or treatment system. Septic tanks are utilized throughout the City. Should the City desire to construct a system as a result of septic tank nuisance or operational difficulties, the collection system proposed in earlier reports and shown on Plate CT-1 would serve the populated area. The cost of this proposed collection system is estimated to be $450,900. The method of treatment required by 1977 that would be most efficient would be a facility of the activated sludge type operated in the extended

aeration mode. The cost of this facility is estimated to be $76,000 including engineering and contingencies. If facilities were constructed and the City is to remain in compliance with the law, by 1983 Lometa should construct and operate irrigation disposal facilities; the estimated capital cost including irrigation equipment, land and holding pond, would be $56,100.

Under the requirements of PL 92-500, publicly-owned waste treatment works must provide secondary treatment of effluent by 1977 and "the best practicable waste treatment technology" by 1983. According to the present interpretation of this law, an activated sludge-type plant would meet all requirements of the law until 1983. At that time, the City would be faced with a choice of either providing a form of tertiary treatment or disposing of all secondary effluent by another means. Also within the interpretation of the above law, irrigation with effluent would meet all requirements when executed in an approved manner and when no effluent is introduced directly into the surface water or ground water resource either as runoff or by direct percolation without adequate treatment time.

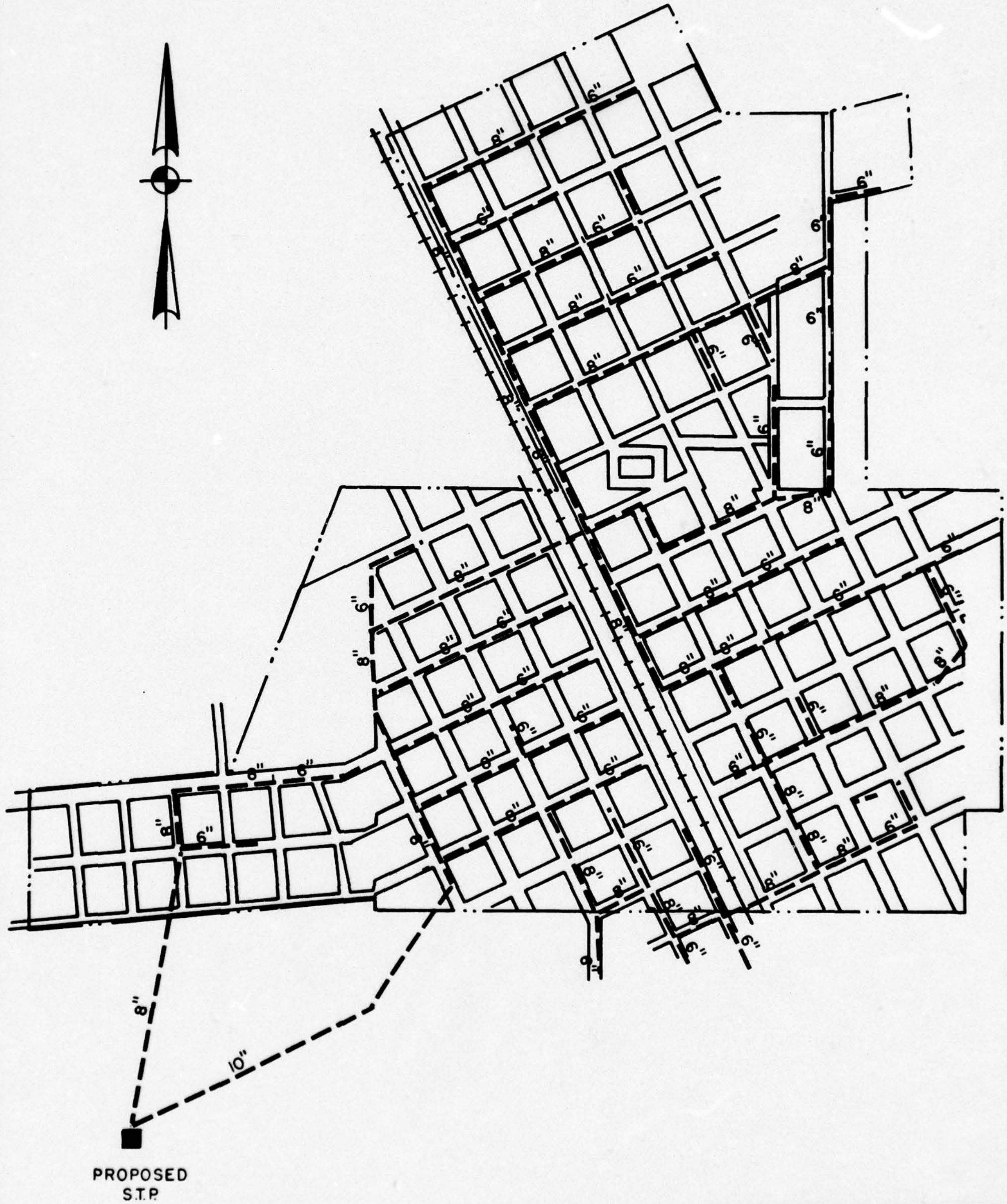
According to data furnished by the General Land Office, there are presently no irrigation sites in the vicinity of Lometa where the effluent could be utilized to substitute for a surface or ground water source currently utilized. Should a treatment system be developed, it is recommended that the City seek out a local farmer who will take the water for irrigation on a year-round basis. An alternative might be a system owned and operated by the City. Costs for the latter alternative, including effluent chlorination, engineering, and contingencies are included in the following feasibility table. Irrigation with effluent is a method of disposal the City would be capable of operating on its limited financial resources. In addition, irrigation would provide a high level of treatment for the wastewater, stimulate the local economy, improve the environment of a semi-arid area, and provide optimum reuse of a scarce natural resource.

It is therefore recommended that all steps necessary to implement the previously described no-discharge plan be undertaken. However, should the City of Lometa wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $76,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $77,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $61,000, including engineering and contingencies.




LEGEND

— — — PROPOSED SEWER LINES

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LOMETA, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: CT-1

## AREAWIDE PLAN
## FOR
## GOLDTHWAITE, TEXAS

**The City of Goldthwaite is an incorporated, general law municipality located in the central portion of Mills County at the intersection of U.S. Highway 84 and State Highway 16 approximately 95 miles north-northwest of Austin, Texas. The incorporated area of the City encompasses approximately 725 acres. Goldthwaite is the county seat of Mills County and is within the jurisdiction of the Central Texas Council of Governments.**

**The City has moderate topographical relief and is drained by Cryers Branch and the North Fork of Bull Creek. The City slopes toward the west, dropping approximately 100 feet. There is a slight ridge which runs from east to west through the center of the City. The northern part of the City drains toward the northwest into Cryers Branch, while the central and southern portions flow in a southwesterly direction into the North Fork of Bull Creek. The City is underlain by soils of the Tarrant-Brackett types. The Tarrant-Brackett soils are composed of a 4 to 8-inch-thick surface of grayish brown, friable, calcareous clay over weathered limestone and limestone bedrock at less than 12 inches below the surface. Permeabilities range from 0.2 to 0.63 inch per hour, and septic tanks have severe limitations due to the shallowness of the limestone bedrock.**

**Population data, developed by the Texas Water Development Board for use in this study, indicate a moderate decrease in population expected for Goldthwaite over the next fifty years. The population estimates are as follows:**

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,693 | 1,590 | 1,490 | 1,110 |

**The land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City and along the major highways. The economic resource base is primarily agricultural with little industrial contribution.**

The City is accessible by U.S. Highways 84 and 183, State Highway 16, F.M. 574 and F.M. 572 and is served by the Atchison, Topeka and Santa Fe Railroad. Population growth is not anticipated due to a lack of adequate economic activity and resource availability. It is anticipated that the City will continue as a localized agricultural community.

The municipal water supply is obtained from ground water and surface water sources. Storage for the system is provided by a 0.50 mg elevated tank, two ground tanks with capacities of 0.042 and 0.15 mg, and a surface reservoir with a capacity of 18 mg. Three wells serve the City, in addition to water pumped from the Colorado River. The wells have pumping capacities of 40, 50, and 50 gpm.

The projected water use is a reflection of the population trend and has been projected by the Texas Water Development Board to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.51 | 0.52 | 0.50 | 0.40 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd: | 0.17 | 0.16 | 0.15 | 0.11 |
| BOD in lb/day: | 290 | 290 | 270 | 210 |
| TSS in lb/day: | 340 | 330 | 330 | 250 |

The only known industrial contribution to the plant influent is from a small slaughterhouse which discharges rinsings and wash water. Reportedly, all blood and solids are retained at the slaughterhouse for

disposal elsewhere. It has been estimated in prior reports that the contribution from this facility is approximately 10 pounds of BOD per day.

The existing wastewater collection system is generally adequate for present needs and with only minor expansions and extensions should meet the future needs of the declining population. There are a few scattered areas of town where septic tanks are still the primary means of sewage disposal. However, the City generally has plans to extend service to these areas, as requested. The estimated cost for the extensions shown on Plate CT-2 is $98,700, including engineering and contingencies.

The existing sewage treatment plant for the City of Goldthwaite is located to the southwest of the inhabited area, as shown on Plate CT-2. The plant was built in 1935 with a design capacity of 0.15 mgd and presently serves about 1,400 people. It has been maintained in fair physical condition, considering its age. The plant consists of an Imhoff tank followed by an oxidation pond. Available sampling data published by the Texas State Department of Health and by the TWQB are as follows:

Influent-Effluent Data (mg/l)

| | TSDH (1972) | TWQB (1969) |
|---|---|---|
| Raw BOD: | 240 | 160 |
| Raw TSS: | 230 | 185 |
| Final BOD: | 310 | 70 |
| Final TSS: | 166 | 152 |

Sludge disposal consists of using the dried sludge as fertilizer and the effluent is used for irrigation of pasture lands adjacent to the plant. Irrigation is apparently practiced on a year-round basis on agreement with the local farmer who owns the surrounding land. Withdrawal for irrigation is either on a need basis by the farmer or on request by the City when the oxidation holding pond begins to reach capacity.

The City has under consideration a proposal to abandon the Imhoff tank and construct a small activated sludge-type conventional secondary treatment plant, retaining the oxidation pond for irrigation storage. Considering the age and condition of the Imhoff tank and the odors that may be generated from the present plant in close proximity to the inhabited area, this report is in general concurrence with the above proposal. Waste load and population projections accomplished for this study indicate a facility designed to a capacity of 0.2 mgd would be adequate to serve the declining population; however, the City may choose to provide slight additional capacity in anticipation of unforeseen development. The estimated total project cost for construction of 0.2 mgd conventional secondary facility by 1977 would be $193,100, including engineering and contingencies. It is recommended that the plant be of the activated-sludge type operated in the contact-stabilization mode unless extended aeration can be locally justified at this capacity.

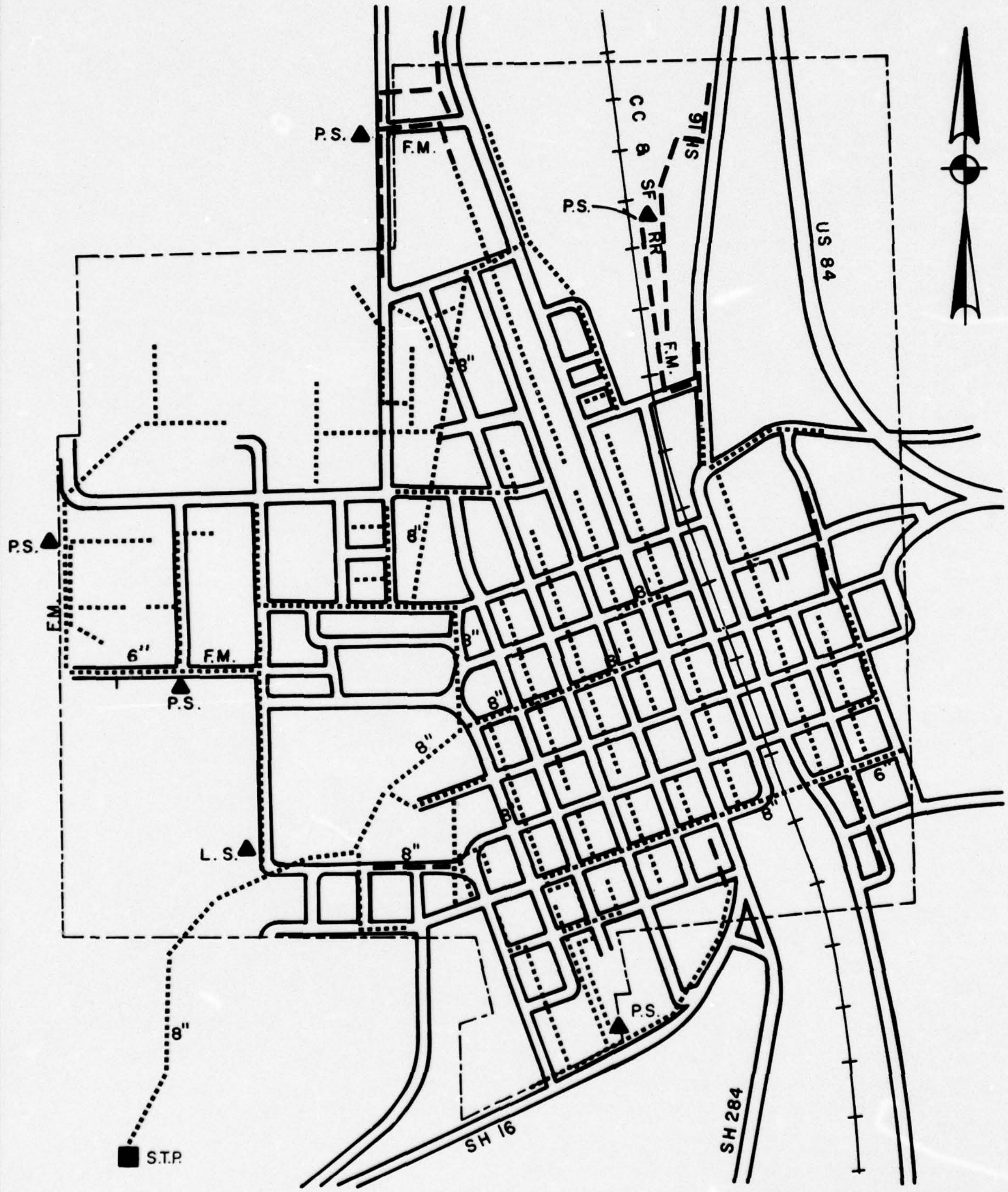
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the "the best practicable waste treatment technology" by 1983. According to the present interpretation of this law, land disposal of effluent as practiced by Goldthwaite meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface water or ground water resource either as runoff or by direct percolation without adequate treatment time.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Goldthwaite wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $193,100, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $114,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $103,500, including engineering and contingencies.




NOTE : ALL UNMARKED LINES ARE 6"

**LEGEND**

| | |
|---|---|
| ············ | EXISTING SEWER LINES |
| — — — — | PROPOSED SEWER LINES |

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

GOLDTHWAITE, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: CT-2

## AREAWIDE PLAN
## FOR
## RICHLAND SPRINGS, TEXAS

The City of Richland Springs is an incorporated, general law municipality located in the north central portion of San Saba County at the intersection of U.S. Highway 190 and F.M. 45 approximately 120 miles northwest of Austin, Texas. The incorporated area of the City encompasses about 950 acres and lies within the jurisdiction of the Central Texas Council of Governments.

The topographic relief of the City is moderate, with elevations decreasing about sixty feet in a southwest to northeast direction. Richland Springs Creek, along the City's northern boundary, and Hooten Hollow Creek, along the eastern boundary, drain the area.

The City is predominately underlain by the Frio-Norge soils, although there are some Crawford-Tarrant stony and gravelly clays along the southern edge. The Frio-Norge soil types, generally 15 to 25 inches thick, have a calcareous loam to silty clay surface over a clay loam to silty clay which is sometimes underlain by stratified, gravelly, and sandy sediments. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks have slight limitations due to slow permeability and flooding hazards, and sewage lagoons have only slight limitations. The Crawford-Tarrant soil type, generally 8 to 12 inches thick, has a clay surface over broken or partly weathered limestone or limestone bedrock. Permeabilities range from 0.2 to 0.63 inch per hour. Limitations on both septic tanks and sewage lagoons are severe due to the shallowness of depth to the limestone bedrock.

Population data, developed by the Texas Water Development Board for use in this study, indicate that a sizeable decrease in population is expected for Richland Springs over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 425 | 330 | 260 | 120 |

The land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major throughfares in the

central areas of the City. The economic resource base is primarily agricultural with some contribution from a peanut-processing plant and a locker plant. Accessible by U.S. Highway 190 and F.M. 45, the City is served by the Atchison, Topeka, and Santa Fe Railroad. There is no anticipated growth potential due to inadequate economic activity and lack of a developable natural resource.

The municipal water supply, obtained solely from ground water, is stored in a 0.05 mg capacity elevated storage reservoir. The City is served by one 225 gpm well and by a spring equipped with a 150-gpm pump. The projected water use, a reflection of the population trend, has been projected by the Texas Water Development Board to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.04 | 0.04 | 0.03 | 0.01 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd: | 0.04 | 0.03 | 0.03 | 0.01 |
| BOD in lb/day: | 72 | 59 | 47 | 23 |
| TSS in lb/day: | 85 | 69 | 57 | 28 |

The existing wastewater collection system is shown on Plate CT-3. It appears that the system is adequate for present needs and with only minor extensions and expansions will meet the future needs of the declining population. Septic tanks are still the primary means of sewage disposal for scattered isolated areas northwest and southeast of the City. However, the distance between units is great and no known problems result from their use.

The existing sewage treatment plant for Richland Springs is located 1,500 feet northeast of the City, as shown on the Plate. Constructed in 1964 with a design capacity of 0.05 mgd, the plant presently serves about 700 people and one small locker plant. The facility, of the Imhoff oxidation pond type, has been maintained in excellent physical condition. The plant consists of a bar screen, grit chamber, Parshall flume and recorder, Imhoff tank, sludge beds and an oxidation holding pond. Available sampling data published by the Texas State Department of Health and by the TWQB is as follows:

Influent-Effluent Data (mg/l)

| | TSDH (1972) | TWQB (1969) |
|---|---|---|
| Raw BOD | - | 110 |
| Raw TSS | - | 102 |
| Final BOD | 25 | 30 |
| Final TSS | 19 | 109 |

Sludge disposal consists of drying the material on beds and then burning it; effluent from the oxidation pond is used in part for irrigation of 17 acres of oat fields and 3 acres of Coastal Bermuda grass. The remainder is discharged into Richland Springs Creek.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and "the best practicable waste treatment technology" by 1983. According to the present interpretation of this law, the effluent constituent levels which will be utilized to define "secondary treatment" will not be attainable by an Imhoff oxidation pond facility. However, land disposal of effluent through irrigation as practiced by the City of Richland Springs meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced into the surface water or ground water resource, whether as direct runoff or by direct percolation without adequate treatment time.

In order to be in full compliance with the law, the City should expand its irrigation operation by 1977 into a year-round operation that would prevent any discharge into the creek. To effect this, the City

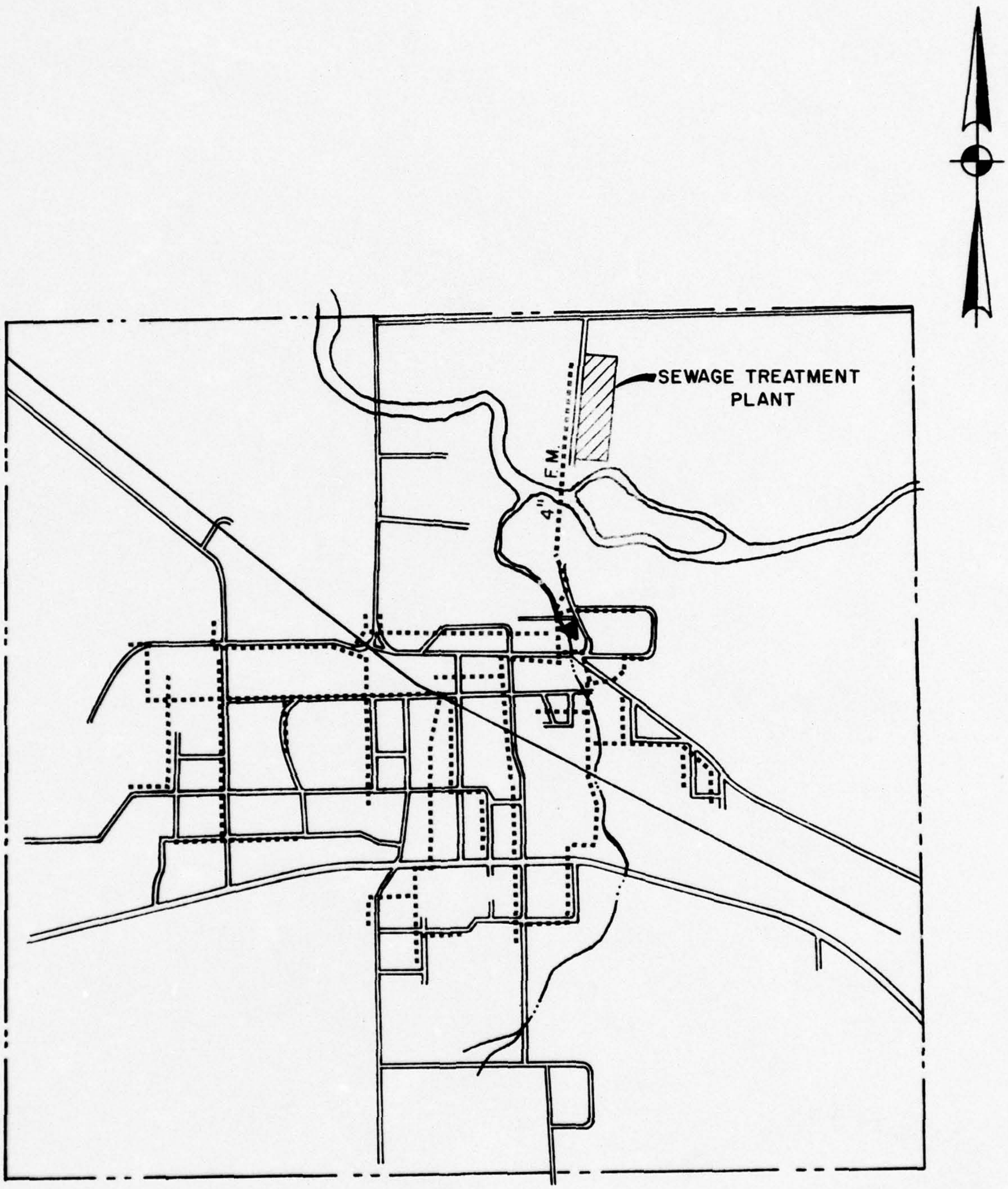
should provide an onsite storage reservoir capable of retaining at least 60 days of effluent. The cost of this lagoon is estimated to be $22,500, including engineering and contingencies. Irrigation will provide a high level of treatment within the financial capability of the City that will be beneficial to the environment in a semi-arid area.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Richland Springs wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $68,700, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including total filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,400, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including denitrification and further phosphorus reduction facilities at an approximate capital cost of $58,000, including engineering and contingencies.




NOTE: ALL UNMARKED LINES ARE 6"

LEGEND

........... EXISTING SEWER LINE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

RICHLAND SPRINGS, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1167'
PLATE: CT-3

AREAWIDE PLAN
FOR
SAN SABA, TEXAS

The City of San Saba is an incorporated general law municipality located in the south-central portion of San Saba County at the intersection of U.S. Highway 190 and State Highway 16, approximately 110 miles northwest of Austin, Texas. The incorporated area of the City encompasses approximately 970 acres. San Saba, the county seat of San Saba County, is a member of the Central Texas Council of Governments.

The City has moderate topographic relief with ground elevations decreasing approximately 80 feet in a southwest to northeast direction. The City is drained by Mill Creek on the east and by the San Saba River on the north.

The City is underlain by soils of the Frio-Norge type. The Frio-Norge soils, generally 15 to 25 inches thick, have a calcareous loam to silty clay surface over a porous, crumbly, strongly calcareous, clay loam to silty clay, underlain by stratified gravelly and sandy sediments. Permeabilities range from 0.2 - 0.63 inch per hour and septic tanks have severe limitations due to flooding and slow permeability.

Population data, developed by the Texas Water Development Board for use in this study, indicate that a rather rapid decrease in population is expected for San Saba over the next fifty years. The population estimates are as follows:

Population Projections

| | | | | |
|---|---|---|---|---|
| Year: | 1970 | 1980 | 1990 | 2020 |
| Population: | 2,555 | 2,070 | 1,660 | 830 |

Land use for the City appears typical of that of other small cities and is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central area of the City. The economic resource base is primarily agricultural with some light industrial contributions from gravel pit operations, stone processors, and a locker plant.

Accessible by U.S. Highway 190 and State Highway 16, San Saba is served by the Atchison, Topeka and Santa Fe Railroad. Because of a lack of adequate industrial activity or developable resource no population growth is anticipated.

The municipal water supply is obtained from ground water sources and is stored in two ground storage reservoirs with capacities of 0.020 mg and 0.094 mg respectively, a 0.10 mg capacity elevated reservoir, and a 0.50 mg capacity stand-pipe reservoir. Two 600 gpm and two 650 gpm shallow (20-30 ft.) wells serve the City. The anticipated water use, a reflection of the population trend, has been projected by the Texas Water Development Board to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.62 | 0.55 | 0.45 | 0.23 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd: | 0.26 | 0.21 | 0.17 | 0.08 |
| BOD in lb/day: | 430 | 370 | 300 | 160 |
| TSS in lb/day: | 510 | 430 | 360 | 190 |

The existing wastewater collection system is shown on Plate CT-4. The system is generally adequate for present needs and, with only minor extensions, should meet the needs of the declining population. The collection system presently has problems with infiltration which is reported to cause overflows during periods of heavy rainfall. There is a low-lying area in the northwest portion of the City and areas west and east of the city limits where septic tanks are still the primary means

of sewage disposal. The low-lying area, shown near the proposed lines and pump station on Plate CT-4, would be costly to serve and maintain due to the need for the force main. The feasibility of ever bringing this area into the system is somewhat questionable. It is estimated the total project cost for a system to serve this area would be $96,500, including engineering and contingencies. The annual operation and maintenance costs are estimated to be $2,300. The septic tank areas east of the city limits could readily be served, but service should be either under special contract and rates or contingent upon the area residents petitioning for annexation into the city limits. It is estimated the total project cost to serve this area would be $47,800, including engineering and contingencies. The remainder of the City is served by 4-inch to 12-inch vitrified clay pipes with some sections of cast iron pipe. The City has presently contracted a detailed study of the adequacy of its main trunk line to the treatment plant.

The existing sewage treatment plant for the City of San Saba is located one mile northeast of the City on the south side of the San Saba River as shown on Plate CT-4. Constructed in 1962, with a design capacity of 0.126 mgd, it presently serves 2,700 people and a locker plant. It was modified in 1968 by the addition of sludge drying beds and is presently maintained in fair condition. The plant is of the Imhoff oxidation pond type and consists of an Imhoff tank, two sludge beds, and an oxidation pond constructed by damming a narrow creek bed. Available sampling data published by the TWQB is as follows:

Influent-Effluent Data (mg/l)

| | TWQB (1969) |
|---|---|
| Raw BOD | 395 |
| Raw TSS | 341 |
| Final BOD | 70 |
| Final TSS | 119 |

The oxidation ponds receive surface runoff from a small drainage area, but according to the local Superintendent, no discharge has ever occurred from the ponds. The ponds have recently been followed by a small impoundment at the local golf course which further insures no release of water. Water released into this impoundment is used for irrigation of the golf course.

Sludge disposal consists of drying the material and then spreading it on farm land; effluent from the oxidation pond which is not released to the pond at the golf course is used for irrigation purposes all year long by an adjacent farmer.

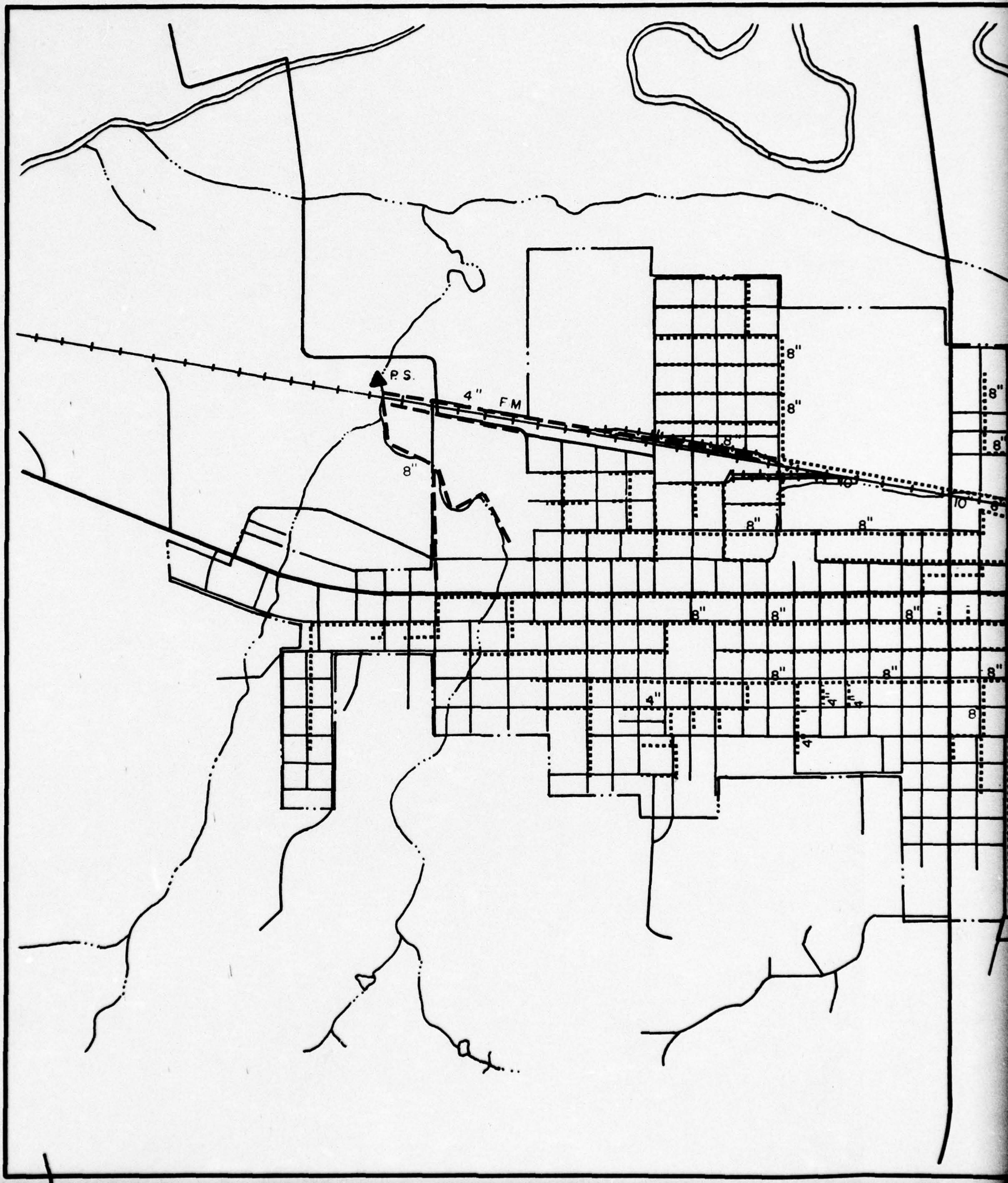
Under the requirements of PL 92-500, publicly owned treatment works must provide secondary treatment of effluent by 1977 and "the best practicable waste treatment technology" by 1983. According to the present interpretation of this law, land disposal of effluent as practiced meets all requirements when the disposal is carried out in an approved manner and when no effluent is introduced directly into the surface water or ground water resource either as runoff or by direct percolation without adequate treatment. The current operational agreement with a local farmer is apparently working satisfactorily. The operation is thus beneficial to the local economy while providing a high degree of final treatment and reclaiming a valuable water resource in a semi-arid area.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of San Saba wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $121,600, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $102,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $99,000, including engineering and contingencies.



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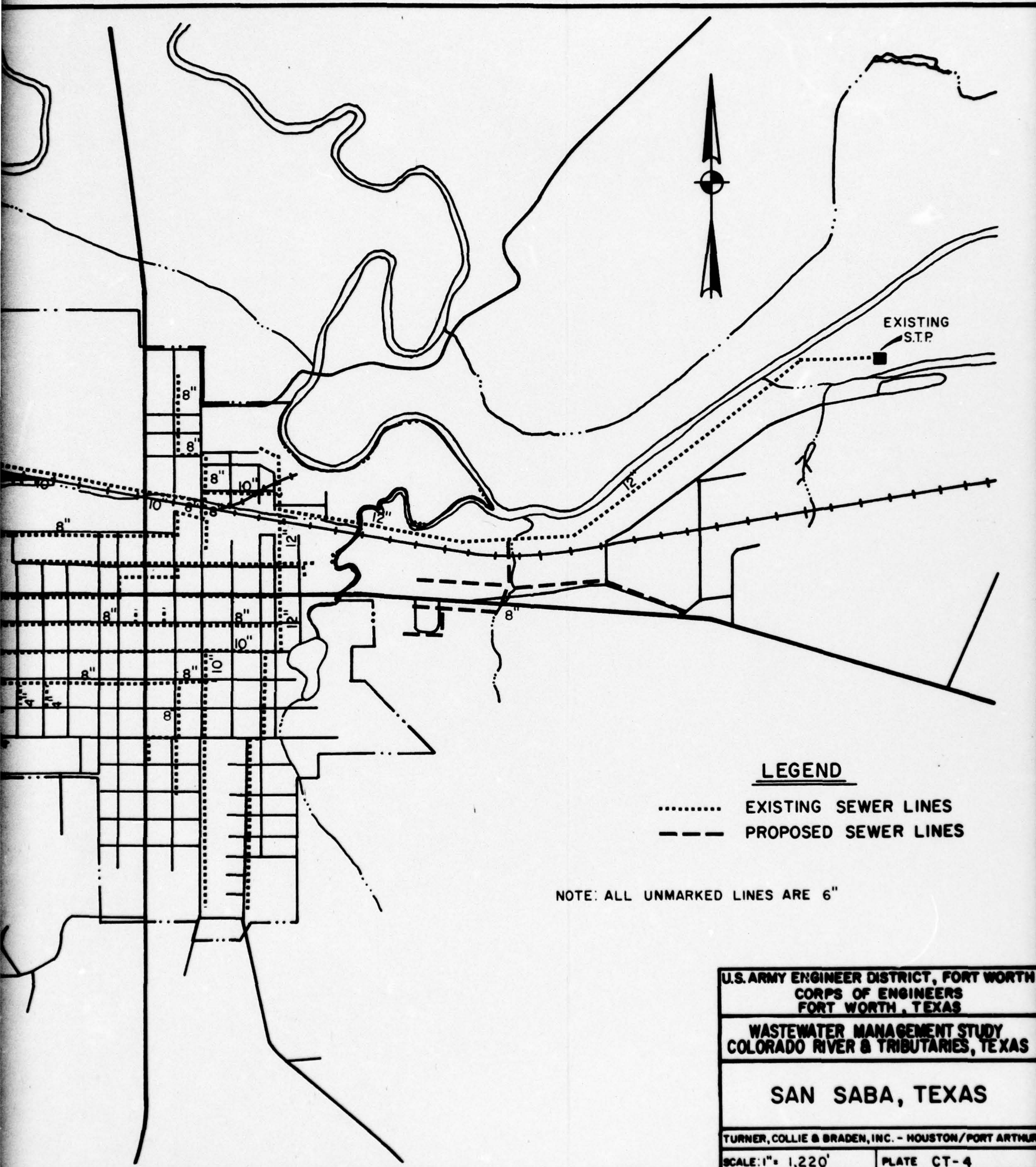
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EXISTING SEWER LINES
PROPOSED SEWER LINES
NOTE: ALL UNMARKED LINES ARE 6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
SAN SABA, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1,220'
PLATE CT-4

## Introduction.

The purpose of this section of the report is to present the areawide plan for the area within the boundaries of the Concho Valley Council of Governments and within the Colorado River Basin. This section consists of an introductory sub-section giving a general physical, social and economic description of this area, followed by a sub-section for the metropolitan area of San Angelo and a sub-section for the non-metropolitan areas.

The foremost objectives of the areawide plans presented in this section are as follows:

1. To recommend the best plan which will satisfy the requirements of PL 92-500 and the waste load allocations as set forth for the Colorado River Basin for each community presently having or in need of a municipal sewerage system.

2. To present the three best alternative plans which will meet the highest level of treatment for the San Angelo metropolitan area.

## Planning Authority.

The planning coordination agency for this study area is the Concho Valley Council of Governments, with offices located in San Angelo. The Council is composed of an Executive Committee and a General Assembly. The Executive Committee has the authority to propose budget and membership fees to the General Assembly, to appoint special committees, to nominate a slate of officers for General Assembly approval and to conduct the business of the Council within policy guidelines of the General Assembly. It appoints an Executive Director, recommends and approves regional policies, and serves as a financial control body. The General Assembly adopts budget and membership fee schedules, adopts and amends bylaws, reviews actions of the Executive Committee, and proposes, initiates or approves policies and plans.

In addition to cities and counties which may implement plans, there are several other implementing types of agencies within this area who have varying responsibilities. These include:

Coke County - Kickapoo Water District

Coke County Soil and Water Conservation District

Colorado River Municipal Water District

Concho Soil and Water Conservation District

Eldorado Divide Soil and Water Conservation District

Menard County Soil and Water Conservation District

Middle Concho Soil Conservation District #234

North Concho River Soil and Water Conservation District

San Saba - Brady Soil and Water Conservation District

Upper Colorado River Authority

Upper Llano Soil and Water Conservation District

## Physical Description of Planning Area.

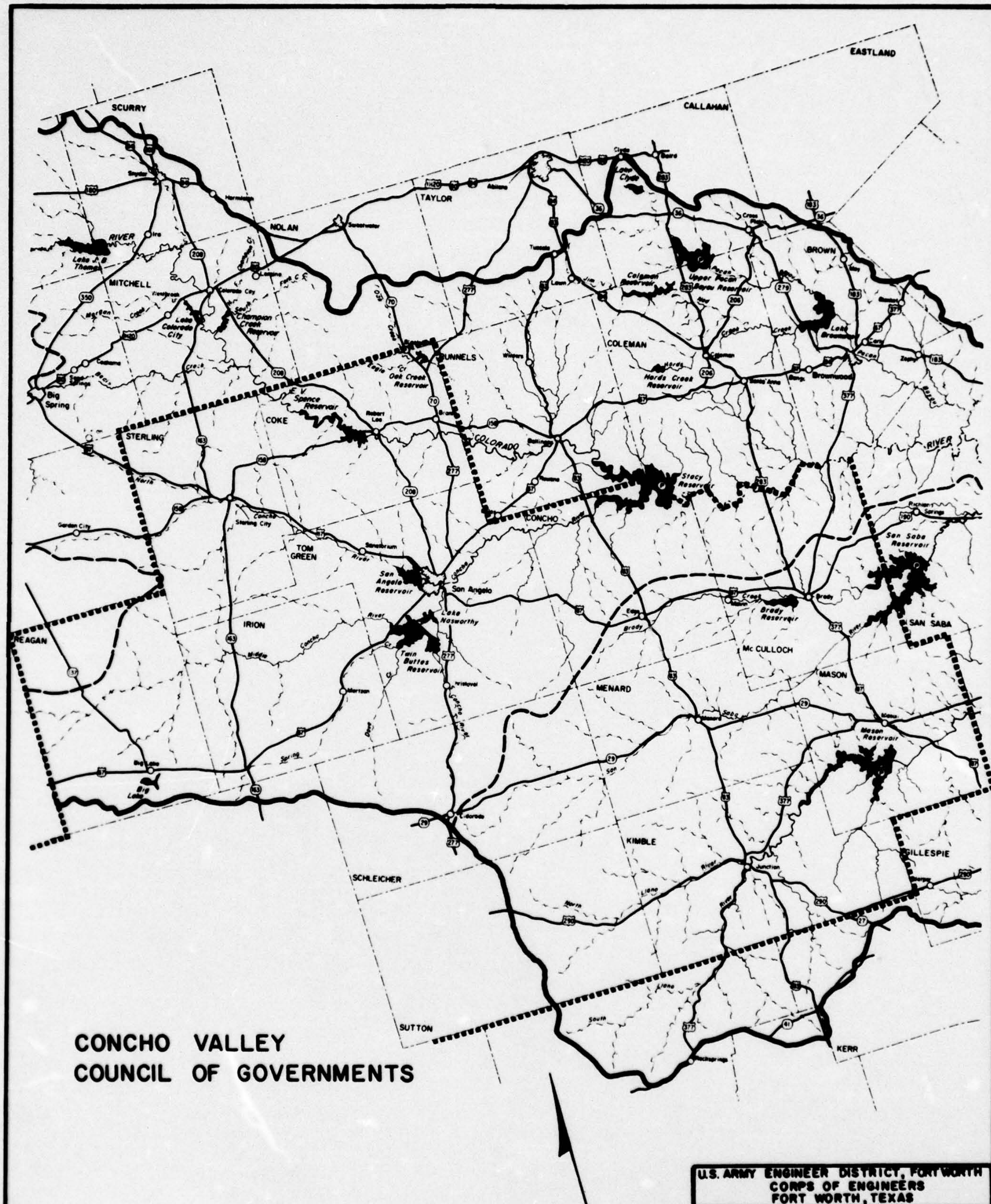
### Study Area Delineation.

The planning area is located in the west central sector of the State of Texas. The study area includes all of Coke, Concho, Irion, Kimble, Mason, McCulloch, Menard, Sterling and Tom Green Counties, nearly all of Reagan and Schleicher Counties, approximately half of Sutton County, and a minor portion of Crockett County, as shown on Plate CV-A.

### Climatic Description.

The climate of this study area can best be classified as "sub-humid." The mean annual temperature for the area is 65$^{\circ}$F. The average growing season (period between last winter frost to first fall frost) is 232 days. Frost and snow occurrence, measured as minimum temperature less than 32$^{\circ}$F, averages 54 days.

The mean annual rainfall varies from 15 inches in western Reagan County to 26 inches in eastern McCulloch and Mason Counties. Inversely, the average annual net evaporation rate varies from about 45 inches in southeastern Mason County to 70 inches in southwest Reagan County. During a drought period such as the one which occurred from 1950 to 1956, the net evaporation rates can be expected to increase 15-20 percent over normal, whereas the annual rainfall may decrease 20-25 percent below normal.




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

CVCOG STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 25 MI. PLATE: CV-A

The prevailing winds are from the south and southeast, averaging 10.4 miles per hour. The average annual relative humidity varies from 76 percent at 6 a.m. to 43 percent at 6 p.m.

Hydrology.

The topography of the study area is rolling but seldom steep, except for escarpments and divides in the north and west. Undulating but rising slopes occur from east to west along the southern portion of the area, with somewhat steeper grades present in the river valleys. The area drains to the Colorado River by way of several tributaries, including the North Concho River, Concho River and San Saba River.

Stream flow varies somewhat over the study area. Average discharge on the North Concho River varies from 10.7 cfs at Sterling City to 42.4 cfs near Sanatorium. Flow in the Concho River below San Angelo is regulated by San Angelo Reservoir, Twin Buttes Reservoir and Lake Nasworthy. Discharge of the Concho River near San Angelo averages 14.3 cfs and increases to 19.4 cfs at U.S. 83 in Concho County. Average discharge of the San Saba River at Menard is 64.8 cfs. The Colorado River near Silver in northwestern Coke County has an average discharge of 12.4 cfs.

Water Resources.

Lack of water is one of the major problems of the Concho Valley region. The water crisis is most evident in the San Angelo area, where population has reached such large and concentrated numbers that water supplies are found to be inadequate.

Availability of ground water in the study area is somewhat limited and, in general, is projected to decline over the study period. The study area has one primary aquifer, the Edwards-Trinity Plateau, and two secondary aquifers, the Ellenburger - San Saba and Hickory which occur in the southeastern portion of the study area. The two secondary aquifers affect only Concho and Menard Counties. Other aquifers exist, but these are more limited in areal extent. They have a limited potential but supply small to moderate quantities of ground water for municipal, industrial, irrigation, domestic or livestock-watering purposes.

Surface water is also used as a water supply. The major reservoirs are the San Angelo Reservoir, Twin Buttes Reservoir, Lake Nasworthy,

E. V. Spence Reservoir, Oak Creek Reservoir and Brady Lake. Several other smaller lakes provide local water supply for municipal, industrial and agricultural uses throughout the area. Three major reservoirs which have been proposed for the future are Stacy Reservoir on the Colorado River near the northeastern corner of Concho County, Mason Reservoir on the Llano River in southwestern Mason County, and San Saba Reservoir on the San Saba River near southeastern McCulloch County. Municipal, industrial and irrigational water use projections for the portion of the Concho Valley Council of Governments within the Colorado River Basin are shown in Tables CV-1 and CV-2.

### Geology.

The surface geology of most of the study area is of the Cretaceous age. However, portions of Coke, Tom Green and Concho Counties are of the Permian Age and Mason and McCulloch have a surface geology characteristic of several different ages.

Three general land resource areas exist in the study area. Most of Tom Green County, the northeastern portion of Coke County, and the northwestern portion of Concho County lie in the Rolling Plains area. Most of Mason County lies in the Central Basin area. The remainder of the area lies in the Edwards Plateau area. The soils of the Rolling Plains are generally dark brown to reddish-brown, neutral to slightly calcareous sandy loams, clay loams and clays. The soils of the Central Basin are reddish-brown to grayish-brown, neutral to slightly acid sand loams and clay loams, with some areas of stony soils. The soils of the Edwards Plateau are dark, calcareous stony clays and some clay loams.

## Social and Economic Description of Planning Area.

### Population.

Table CV-3 gives the existing and projected populations for each county or portion of a county within the study area, as furnished by the Texas Water Development Board. Also include in Table CV-3 are the existing and projected total population, urban population and rural population. The urban population consists of the populace of San Angelo, Brady and Junction, which have a population greater than 2,500 persons. The rural population consists of the populace of those communities with a population less than 2,500, plus the persons living on farms or in the country.

## TABLE CV-1

## MUNICIPAL AND INDUSTRIAL WATER USE

**(AC-FT PER YEAR)**

| | MUNICIPAL | | | | INDUSTRIAL | | | |
|---|---|---|---|---|---|---|---|---|
| COUNTY | 1970 | 1980 | 1990 | 2020 | 1970 | 1980 | 1990 | 2020 |
| COKE | 501 | 494 | 448 | 317 | 1,018 | 1,662 | 1,975 | 3,171 |
| CONCHO | 415 | 357 | 290 | 148 | 0 | 0 | 0 | 0 |
| CROCKETT | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 |
| IRION | 98 | 100 | 104 | 92 | 28 | 32 | 35 | 44 |
| KIMBLE | 894 | 946 | 953 | 923 | 598 | 665 | 709 | 860 |
| MASON | 570 | 499 | 425 | 260 | 0 | 0 | 0 | 0 |
| McCULLOCH | 1,826 | 1,608 | 1,423 | 890 | 694 | 728 | 780 | 964 |
| MENARD | 458 | 491 | 484 | 410 | 0 | 0 | 0 | 0 |
| REAGAN | 551 | 517 | 483 | 343 | 1,173 | 1,420 | 1,591 | 2,237 |
| SCHLEICHER | 297 | 262 | 220 | 129 | 76 | 93 | 101 | 133 |
| STERLING | 96 | 89 | 81 | 66 | 0 | 0 | 0 | 0 |
| SUTTON | 53 | 50 | 45 | 40 | 0 | 0 | 0 | 0 |
| TOM GREEN | 10,763 | 13,238 | 15,425 | 24,459 | 1,000 | 1,323 | 1,483 | 2,087 |
| TOTAL | 16,526 | 18,154 | 20,383 | 28,079 | 4,587 | 5,423 | 6,674 | 9,496 |

## TABLE CV-2

## IRRIGATIONAL WATER USE

**(AC-FT PER YEAR)**

| | SURFACE WATER | | | | GROUND WATER | | | |
|---|---|---|---|---|---|---|---|---|
| COUNTY | 1969 | 1980 | 1990 | 2020 | 1969 | 1980 | 1990 | 2020 |
| COKE | 1,128 | 534 | 0 | 0 | 178 | 0 | 0 | 0 |
| CONCHO | 1,442 | 1,612 | 1,767 | 1,767 | 426 | 591 | 747 | 720 |
| CROCKETT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IRION | 2,318 | 2,648 | 2,945 | 2,945 | 894 | 828 | 747 | 720 |
| KIMBLE | 3,221 | 3,303 | 3,381 | 4,712 | 615 | 0 | 0 | 0 |
| MASON | 384 | 345 | 326 | 456 | 16,420 | 11,723 | 7,458 | 6,800 |
| McCULLOCH | 645 | 922 | 1,178 | 1,178 | 1,645 | 1,956 | 2,241 | 2,160 |
| MENARD | 3,730 | 4,555 | 5,301 | 5,301 | 60 | 0 | 0 | 0 |
| REAGAN | 0 | 0 | 0 | 0 | 15,434 | 17,128 | 18,675 | 18,000 |
| SCHLEICHER | 164 | 386 | 589 | 589 | 2,947 | 2,979 | 2,988 | 2,880 |
| STERLING | 190 | 410 | 589 | 589 | 4,634 | 3,380 | 2,241 | 2,160 |
| SUTTON | 350 | 260 | 216 | 304 | 0 | 0 | 0 | 0 |
| TOM GREEN | 6,715 | 8,134 | 9,424 | 9,424 | 6,604 | 8,232 | 9,711 | 9,360 |
| TOTAL | 20,287 | 23,109 | 25,716 | 27,265 | 49,857 | 46,817 | 44,808 | 42,800 |

With the exception of Tom Green County, all of the counties are projected to decline in population. The rural population is projected to decline 38 percent by 2020. Due to rapid growth projected for the San Angelo area, the urban population is projected to increase 80 percent by 2020, despite the fact that no growth is anticipated for Junction, and Brady is projected to decrease rapidly in population. Also, due to the anticipated growth of San Angelo, which offsets the anticipated decrease in population in the rest of the study area, the total population within the study area is projected to increase 45 percent. Population projections for each city will be presented later in the individual discussions for the cities. The projection methodology utilized by the Texas Water Development Board is discussed in Appendix A of Volume II, Basin Plan Appendix.

Land Use Analysis.

Approximately 98.5 percent of the study area is comprised of agricultural, ranching, and generally open, undeveloped land. Of this land, approximately 80.8 percent is open range with the rest utilized for crops, pasture, and forests. The remaining 1.5 percent of the study area consists of land utilized for residential, commercial and industrial purposes. Tom Green County has the largest amount of urban and industrial land, which is mostly located in the San Angelo area.

TABLE CV-3

EXISTING AND PROJECTED POPULATION

| County | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Coke | 3,087 | 2,700 | 2,400 | 1,500 |
| Concho | 2,937 | 2,300 | 1,800 | 800 |
| Crockett* | 21 | 20 | 20 | 10 |
| Irion | 1,070 | 1,000 | 1,000 | 800 |
| Kimble | 3,904 | 3,700 | 3,600 | 3,000 |
| McCulloch | 8,571 | 7,400 | 6,400 | 3,800 |
| Mason | 3,356 | 2,700 | 2,200 | 1,200 |
| Menard | 2,646 | 2,400 | 2,200 | 1,500 |
| Reagan* | 3,230 | 2,790 | 2,490 | 1,500 |
| Schleicher* | 2,100 | 1,770 | 1,420 | 760 |
| Sterling | 1,056 | 900 | 800 | 600 |
| Sutton* | 375 | 290 | 260 | 150 |

| | | | | |
|---|---|---|---|---|
| Tom Green | 71,047 | 81,500 | 93,900 | 133,800 |
| | | | | |
| Total COG | 103,400 | 109,470 | 118,490 | 149,420 |
| Total Urban | 72,097 | 81,880 | 93,010 | 129,920 |
| Total Rural | 31,303 | 27,590 | 25,480 | 19,500 |

*Population for portion of county within the Colorado River Basin

County has the largest amount of urban and industrial land, which is mostly located in the San Angelo area.

Economic Analysis.

The major economic base of the area is agriculture and agricultural industries. With the exception of Tom Green County, the economy of the area appears to be declining, as evidenced by present and projected population trends. As indicated in the 1971 Land Resource Study for the Concho Valley Council of Governments, every county in the area showed a negative net migration rate from 1950 to 1970. In Tom Green County, migration is heaviest between the ages of 0 to 14 and 35 to 64. In the other counties it is heaviest between the ages of 15 to 34. This suggests that the people in the outlying regions between 15 and 34 leave their homes to seek opportunity elsewhere, possible in San Angelo. After living in San Angelo for a while, people decide to move with their families to larger metropolitan areas with more opportunities.

Further evidence of below-average economic base conditions can be seen in the 1969 mean per capita incomes. The 1969 mean per capita income for the area, excluding Tom Green County, was $2,310 as compared to $2,810 for the State of Texas. The 1969 mean per capita income for Tom Green County was $2,656. Manufacturing holds major importance in the economy of the study area. Mining is important in Coke and Schleicher Counties.

In summary, Tom Green County is the only area within this planning region which has significant growth potential as evidenced by the population projections. A more detailed discussion of the economy of San Angelo will be given later in this section.

Existing Waste Loads.

Within each area plan which follows, the projected waste loadings as furnished by the TWQB are presented. Those projections, based on

census populations and not service populations, were to be used with judgment for planning purposes throughout the study. The metholology utilized in those projections is presented in the Basin Plan Appendix.

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream.

Very little of the available sampling data was consistent, therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in many of the loadings and estimates presented in Table CV-4.

## TABLE CV-4

## EXISTING WASTE LOADS

## CONCHO VALLEY COUNCIL OF GOVERNMENTS

| City [2] | Estimated Population Served | Discharge | Estimated Influent Loading | | | Estimated Treatment Reduction | Estimated Effluent Loading | |
|---|---|---|---|---|---|---|---|---|
| | | | Flow mgd | BOD lb./day | TSS lb./day | | BOD lb./day | TSS lb./day |
| BRONTE | 700 | No | 0.08 | 100 | 70 | 72% / 10% | 30 | 60 |
| ROBERT LEE | 1,100 | Yes | 0.09 | 190 | 220 | 95% / 88% | 10 | 30 |
| EDEN | 800 | Yes | 0.11 | 170 | 50 | 72% / –117% | 50 | 120 |
| MERTZON | 513 | N/A [1] | 0.04 | 90 | 100 | – | – | – |
| JUNCTION | 2,500 | Yes | 0.21 | 390 | 300 | 72% / 86% | 110 | 40 |
| MASON | 1,800 | Yes | 0.15 | 220 | 180 | 72% / 82% | 60 | 30 |
| BRADY | 6,000 | Yes | 0.51 | 470 | 400 | 80% / 80% | 90 | 60 |
| MENARD | 800 | Yes | 0.07 | 70 | 80 | 62% / 20% | 30 | 70 |
| BIG LAKE | 2,500 | Yes | 0.21 | 480 | 850 | 72% / 87% | 130 | 110 |
| ELDORADO | 1,200 | No | 0.10 | 190 | 190 | 72% / 64% | 50 | 70 |
| STERLING CITY | 780 | N/A [1] | 0.07 | 130 | 160 | – | – | – |
| SAN ANGELO CENTER | 500 | No | 0.04 | 80 | 100 | 80% / 80% | 20 | 20 |
| SANATORIUM–CARLSBAD | 400 | N/A [1] | 0.03 | 70 | 80 | – | – | – |

[1] *No sanitary collection or treatment system.*

[2] *San Angelo existing waste loads detailed in metropolitan plan.*

## AREAWIDE PLAN
## FOR
## SAN ANGELO, TEXAS

Physical Description.

The San Angelo Metropolitan Area in this Report was originally defined as the entire area (1,534 sq. miles) within Tom Green County. This delineation was later adjusted to include only the projected area of metropolitan expansion through the year 2020 as indicated on the land use exhibit on Plate CV-SA-1. The remaining non-metropolitan towns and cities in Tom Green are investigated in detail in the non-metro section of this Report.

San Angelo, the county seat of Tom Green County, lies in the middle of the western portion of Texas. With Abilene to the northeast and Midland-Odessa to the northwest, San Angelo forms a triangle of population concentration in West Texas. As a major center of commerce and population, San Angelo is a western nucleus of highway traffic generation.

Both geologically and climatologically, San Angelo is in transitional zones. In the immediate vicinity of San Angelo, rolling plains merge with a line of hilly outcroppings, and humid air masses from the Gulf of Mexico meet the dry air masses of the west.

The ground elevation of Tom Green County ranges from 2,500 feet to 1,700 feet, sloping in the northeasterly direction. The two natural geographic regions in the county, the Edwards Plateau and the Rolling Plains, are generally demarcated by the 2,000-foot contour.

Soils on the Edwards Plateau are shallow and rocky on hilly, broken terrain that is not suitable for cultivation. On the Rolling Plains in the northeastern quarter of Tom Green County, productive soils derived from outwash and limited areas of deep soils from red beds form the principal croplands of the country. Undeveloped sections of the county are stony with a cover of Mesquite, other brushy vegetation, native midgrasses, and short grasses.

Three rivers, the North, South and Middle Conchos, lying in the Rolling Plains, provide drainage for Tom Green County. The three rivers converge at San Angelo, and from the confluence the Concho River continues approximately 60 miles to the northeast before merging with the Colorado River below Ballinger.

## Population, Historical Growth and Trends.

The City of San Angelo can trace its history back 105 years to the establishment of Fort Concho at the confluence of three rivers: the North, South and Middle Conchos. Serving as a base for campaigns against the Indians, Fort Concho was commanded by such well-known men in Texas history as General Hatch, Colonel Randel MacKenzie, General Merritt, General Shaffer, and Colonel Grierson. The fort was active for 22 years but was abandoned due to a cessation of Indian raids.

A trading post was established across the river from Fort Concho in 1870. By the mid 1870's, the trading post had grown into a village, and in 1876 the first school was established with an enrollment of 12 pupils. The Post Office Department established the present name of San Angelo in 1883 after previous attempts at suitable names were found to be unsatisfactory. The name was chosen in honor of a Mexican nun, Santa Angela.

The county seat was moved from Ben Ficklin to San Angelo in 1882 after Ben Ficklin was destroyed by flood. By the end of 1882, San Angelo had a population of nearly 800. Between the years of 1888 and 1903, the City was unsuccessfully incorporated a number of times; finally in 1903 the City's charter was established.

In 1929, Nasworthy Dam was constructed by the West Texas Utilities Company for a source of cooling water. As a result of the increasing demand for water in 1950, the City purchased Lake Nasworthy for the purpose of municipal water supply. Between the years of 1940 and 1950 the population of San Angelo more than doubled, greatly increasing the demand for water. Consequently, in 1947, the Corp of Engineers began construction of San Angelo Dam located on the North Concho River sited on the City's western limits. Twin Buttes Dam and Reservoir followed in 1962. Still additional sources of water are being pursued. As can be readily seen, the supply of water has been and will continue to be a prime factor in the growth of San Angelo.

Goodfellow Air Force Base was established in 1941 as a pilot training facility, but its mission has since been changed to that of a security base, in which capacity it still serves.

One institute of higher learning, Angelo State University, is located in San Angelo. Formerly a junior college, it became a four-year State-supported college in 1965. Its enrollment now exceeds 4000.

San Angelo and Tom Green County have not shown steady growth, but have varied with the agricultural fortunes of West Texas. A decline in population between 1910 and 1920 can be attributed to a three-year drouth beginning in 1916. Similarly, the growth was hampered by a severe six-year drouth ending in 1956. The historical population growth of San Angelo and Tom Green County from 1910 through the 1970 census is presented in the following table, with respective percent increases by decades from 1920.

Historical Population Trend

| Year | San Angelo | | Tom Green County | |
|---|---|---|---|---|
| | Population | Percent Increase | Population | Percent Increase |
| 1910 | 10,321 | | 17,882 | |
| 1920 | 10,050 | -2.6 | 15,210 | -14.9 |
| 1930 | 25,308 | 151.8 | 36,033 | 136.9 |
| 1940 | 25,802 | 2.0 | 39,302 | 9.1 |
| 1950 | 52,093 | 101.9 | 58,929 | 49.9 |
| 1960 | 58,815 | 12.9 | 64,630 | 9.7 |
| 1970 | 63,880 | 8.6 | 71,047 | 9.9 |

The projected population figures for San Angelo and Tom Green County to be used for this study were prepared by the TWQB and are presented in the following table, together with the projected percent increases.

Projected Population Trend

| Year | San Angelo | | Tom Green County | |
|---|---|---|---|---|
| | Population | Percent Increase | Population | Percent Increase |
| 1980 | 74,050 | 15.9 | 81,500 | 14.7 |
| 1990 | 85,660 | 15.6 | 93,900 | 15.2 |
| 2000 | 97,640 | 14.0 | 106,400 | 13.3 |
| 2010 | 110,500 | 13.2 | 119,700 | 12.5 |
| 2020 | 124,250 | 12.4 | 133,800 | 11.8 |

A breakdown of the 1960 and 1970 San Angelo population by age group indicates that 70 percent of the population is below 45 years of age in both years. The presence of this highly productive age group will be a benefit to San Angelo in attracting additional industries. The following table gives the distribution by age group expressed as a percentage of total population.

Population Age Group Distribution

| Age Group | Percent of Total Population | |
|---|---|---|
| | 1960 | 1970 |
| Under 20 years | 40.5 | 37.5 |
| 20 through 45 years | 31.4 | 32.4 |
| 45 through 65 years | 19.4 | 19.5 |
| 65 years and over | 8.7 | 10.6 |

The ethnic composition of the population of San Angelo and Tom Green County is shown in the following table.

Population Ethnic Composition

| | San Angelo | Percent of Total Population | Remainder of Tom Green Co. | Percent of Total Population |
|---|---|---|---|---|
| Anglo | 48,386 | 75.7 | 6430 | 89.7 |
| Latin American | 12,441 | 19.5 | 710 | 9.9 |
| Negro | 3,057 | 4.8 | 23 | 0.3 |

Land-Use Projection.

In order to fulfill the requirements of the Colorado River Wastewater Management Study, land-use projections were compiled through the year 2020 through efforts of the Corps of Engineers and the San Angelo City Planner working together. At the time this study was prepared, the City of San Angelo had no published land-use projections extending beyond 1985. The land-use projections developed are shown on Plate CV-SA-1.

Population and commercial development in San Angelo is following some clearly defined lines. Several barriers to development are encountered in San Angelo. San Angelo Reservoir is a physical boundary to any western expansion of the northern section of the City, and eastern expansion at the northern section is restricted by litigation concerning an estate. Goodfellow Air Force Base serves as a barrier to development to the east in the south section of the City. The southwest is

expected to be the line of residential and commercial development in the near future. Development to the north of the City is projected to begin in about twenty years.

In projecting land use for San Angelo, close coordination was maintained between the Corps of Engineers and the San Angelo City Planner. Preliminary land-use projections, including estimates of future densities of development, were prepared by the City Planner and presented to the Corps of Engineers. These projections were then refined by the Corps of Engineers, based on the projected population for the years 1980, 1990 and 2020. Final land-use projections were reviewed and approved by the City Planner of San Angelo.

Densities of projected development ranged from seven persons/acre adjacent to existing residential developments to two persons/acre in the areas of expected ranchette-type development. The low density development is projected to occur southwest of the City and north of Lake Nasworthy and also to the north of the City in the presently undeveloped areas. The higher-density normal residential development was projected inside of Loop 306 and adjacent to existing high density residential development.

Existing land use shown on Plate CV-SA-1 was obtained from the "San Angelo Urban Transportation Study" prepared by the Texas Highway Department. A detailed survey of the City was conducted in preparing the existing land use, with periodic updating as necessary.

It is not the intent of this study that the land-use projections developed be accepted as a final document or that growth patterns be construed to be exact as indicated on the exhibit, but that it is a generalized plan to meet the requirements of this study. The rapid growth projected for San Angelo by the Texas Water Development Board will require frequent changes and/or updating of the land use projections.

Economic Trends.

In the early years, the economic picture of San Angelo was dominated by free-range cattle raising and trail driving. In 1877 sheep were introduced to the area, growing to the point that today San Angelo markets more wool than any other city in the nation. The Santa Fe Railroad reached San Angelo in 1888, and the City developed as an important shipping and trade center for a wide area in the western cattle country.

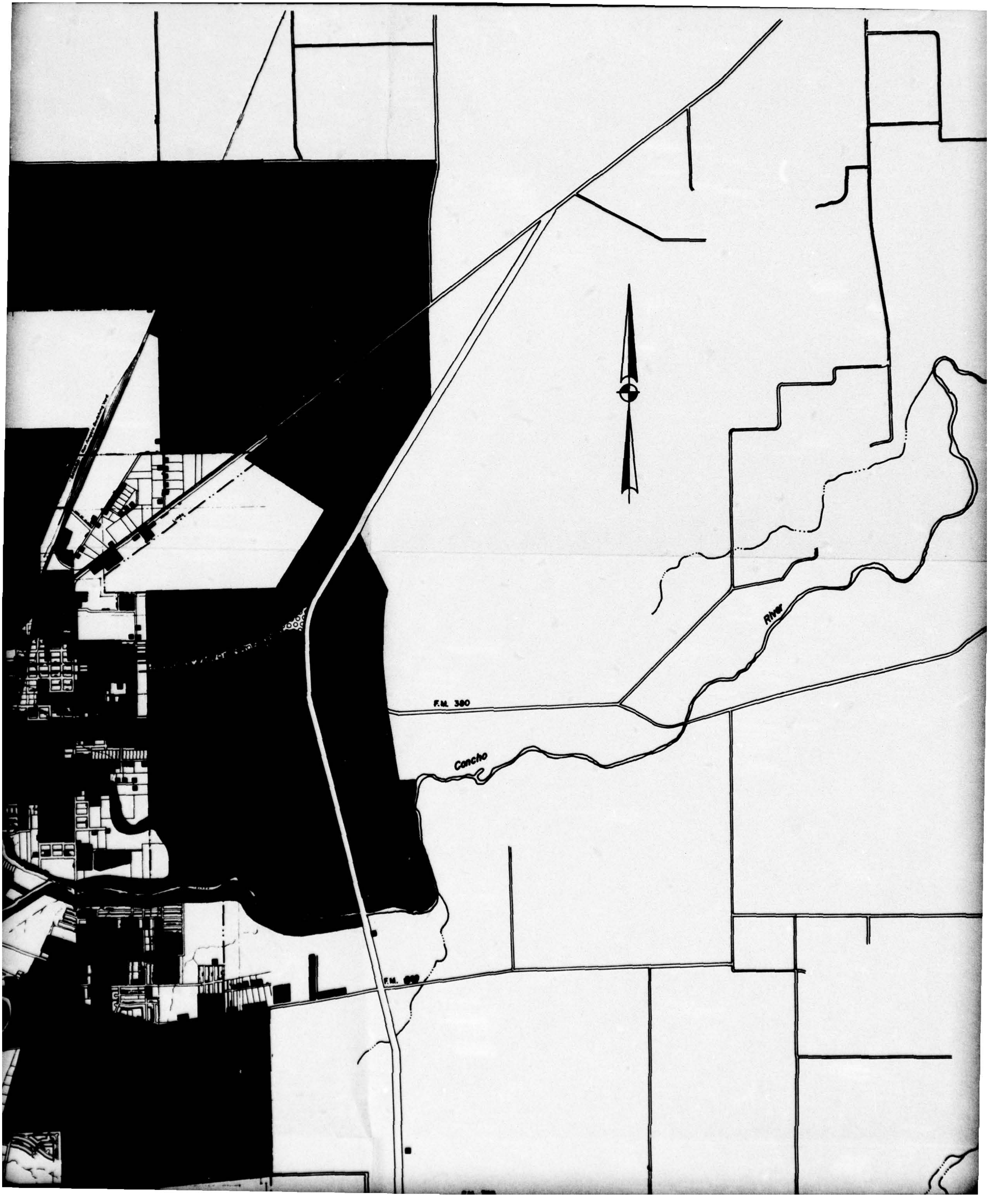
Major petroleum discoveries in the 1920's west of San Angelo in the Permian Basin brought oil producers and service firms to San Angelo; however, the resulting oil production in the county has been small in comparison to other West Texas producing areas.

Development of manufacturing was fairly diverse for a city the size of San Angelo before World War II, but it was not until after the war that employment in manufacturing began to rival employment in agriculture for the immediate area. Recently, San Angelo has began to focus on the expansion of manufacturing and service industries. The following is a list of industries in the San Angelo metropolitan area:

1. San Angelo Wool Process
2. Producer's Auction Company
3. Premium Packing Company
4. Handy Packing Company
5. Armour & Company
6. Wilson Packing
7. Texas Tank Car Company
8. Goodfellow A.F.B.
9. Gandy's Dairies, Inc.
10. Ethicon, Inc.
11. Mid-West Feed Yards
12. Monarch Tile Mfg., Inc.
13. San Angelo Feed Yards
14. San Angelo Rendering Co.
15. Veribest Cattle Feeders
16. R.G. Berry, Corporation
17. Levi-Strauss
18. Aileens' Inc.
19. Mitsubishi Aircraft International Inc.
20. San Angelo Communications and Electronics
21. Terrill Manufacturing
22. Newsphoto, Inc.

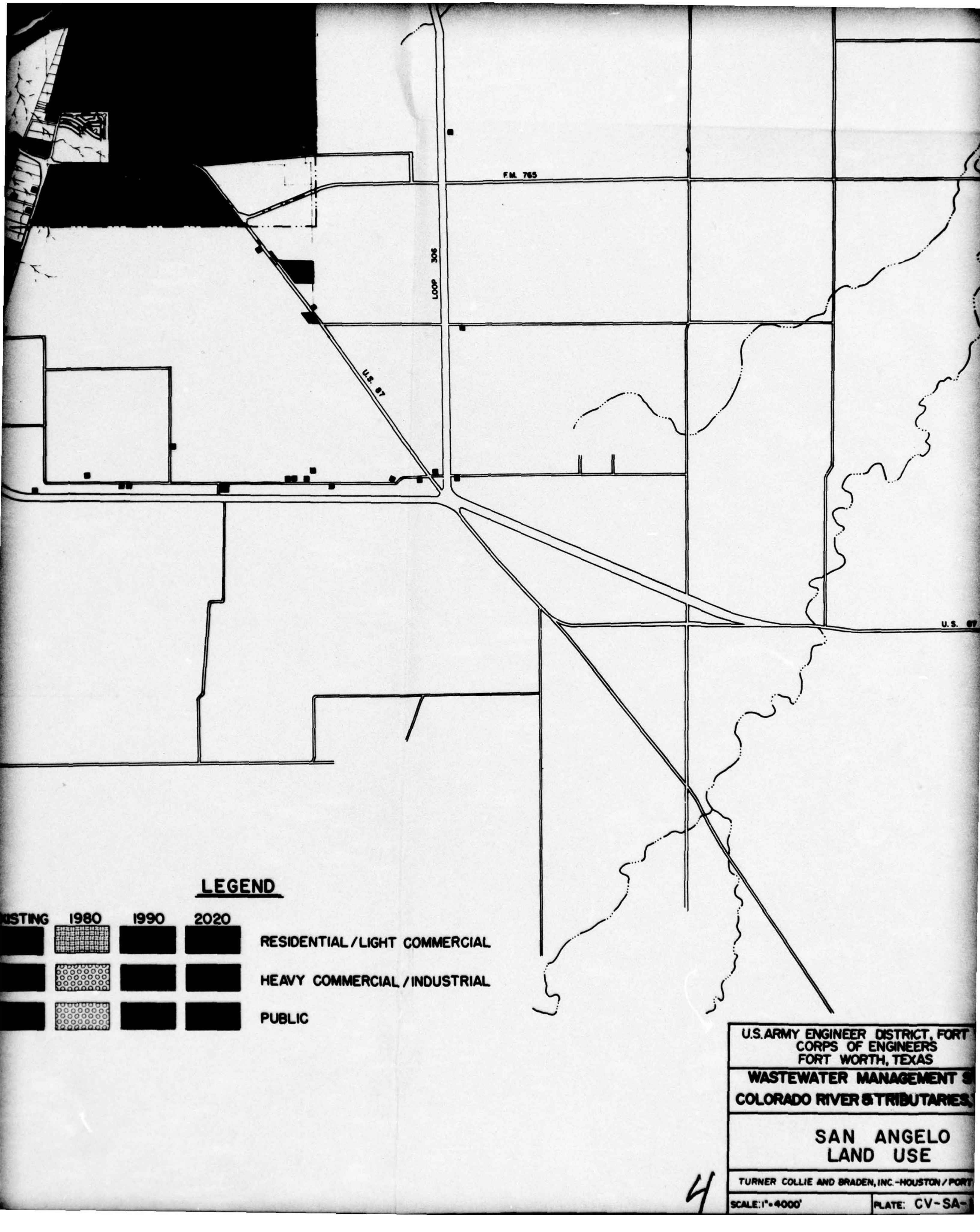
The economic growth of San Angelo is dependent on an available supply of water. Consequently, the growth potential for low water-consumptive industries such as furniture and fixtures and lumber and wood; stone, clay and glass products; fabricated metal products; professional and scientific instruments; apparel manufacturing; and wool processing, just to mention a few, seems very good. The future development of high water-consumptive industries would only contribute to the depletion of the already heavily taxed municipal water supply, thus hindering the development of other industries.

San Angelo Reservoir
F.M. 853



F.M. 380
River
Concho


Lake
Nasworthy
KNICKERBOCKER RD



F.M. 765
LOOP 306
U.S. 87
U.S. 87
LEGEND
EXISTING
1980
1990
2020
RESIDENTIAL / LIGHT COMMERCIAL
HEAVY COMMERCIAL / INDUSTRIAL
PUBLIC
U.S. ARMY ENGINEER DISTRICT, FORT
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT S
COLORADO RIVER & TRIBUTARIES,
SAN ANGELO
LAND USE
TURNER COLLIE AND BRADEN, INC. - HOUSTON / PORT
SCALE: 1" = 4000'
PLATE: CV-SA-
4

Water Resources.

The water supply for San Angelo is presently derived solely from surface water. When water shortage problems have developed in the past, the trend has always been to build another reservoir. This trend is very apparent from the three reservoirs, Lake Nasworth, San Angelo Reservoir and Twin Buttes Reservoir, immediately adjacent to the City. This ideology probably precipitated from the fact that there are no fresh water aquifers to draw from in the San Angelo area.

After water shortages occurred in the consecutive years of 1968, 1969, 1970, and 1971 and it was becoming clear that another reservoir would not solve the problem, an investigation was initiated by the City to determine the possibilities of establishing a well field in Concho, McCulloch and Menard Counties. The results of the investigation was favorable and the City has since purchased the water rights to 36,000 acres of land in Concho, McCulloch and Menard Counties.

The proposed wells will extract water from the Hickory aquifer which has a thickness of 300 to 400 feet at the proposed well field and a depth of 2,500 feet. Twenty-nine or thirty 500 to 600 gpm wells are ultimately projected for the field with a safe yield of 20 mgd. Two test wells have already been drilled and the remaining wells are expected to be drilled at the rate of two or three per year. Right-of-way for the 60 miles of pipeline that will be required to connect the well field with San Angelo is being purchased now, but the pipeline is not expected to be built for 8 to 10 years. If unexpectedshortages do occur, the time frame will be revised. The City also receives surface water from E. V. Spence reservoir via a pipeline operated by the Colorado River Municipal Water District.

Two surface water treatment plants are being operated by the City of San Angelo. The major plant is a 24 to 25 mgd plant which at present supplies an average daily demand of approximately 10 mgd, and services the entire city limits. The plant is located approximately one-half mile upstream from the confluence of the North and South Conchos on the South Concho River.

A second plant is located at Mathis Field with a capacity of 1.0 mgd. The plant has an average usage at 100,000 gpd and serves the air field and the commercial and industrial development around the field. Water is supplied to the plant from Lake Nasworthy.

Municipal and industrial water use for this study have been projected by the Texas Water Development Board. They are as listed in the table below.

Water Use Projections*

| Water Use | 1970 | 1975 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|
| Municipal | 10,106 | 11,536 | 12,566 | 14,953 | 23,596 |
| Industrial | 318 | 397 | 421 | 472 | 664 |

*In acre-feet

Waste Load Analysis.

Municipal Waste Load.

Municipal wastewater return flows, projected for San Angelo by the TWQB, are as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow (mgd): | 5.42 | 6.29 | 7.28 | 10.56 |
| BOD (lb./day): | 10,860 | 13,329 | 15,419 | 23,608 |
| TSS (lb./day): | 12,776 | 15,550 | 18,845 | 28,578 |

Existing and anticipated service areas for the planning phases of this report have been delineated and are shown on Plate CV-B-2.

Urban and Agricultural Runoff.

San Angelo lies entirely within the Concho River watershed. Storm flows in the river consist of urban runoff from the City in addition to agricultural runoff from the surrounding farmland. The principal source of pollutants in urban runoff include:

1. Street and parking lot litter, oil and grease.

2. Animal and bird wastes deposited on impervious surfaces.

3. Fertilizers from lawns and parks.

4. Pesticides.

5. Suspended solids from excavation and construction activities and from unpaved and unplanted areas.

6. Leaves and grass.

7. Air pollutants which settle or are washed out by rain.

8. Unauthorized waste discharges into gutters, streets, open ditches, etc.

9. Overflowing manholes in overloaded sanitary sewer systems.

Sources of agricultural runoff pollution include:

1. Inorganic fertilizers.

2. Animal and poultry wastes.

3. Insecticides and herbicides.

4. Silt and other suspended solids.

Concentrations of pollutants in runoff depend on the amounts available to be washed away by rain, time interval between rains, and the intensity and duration of rainfall. Existing studies seem to indicate that urban runoff is generally much higher in concentration of pollutants than agricultural runoff.

Since the City of San Angelo was built on the banks of three rivers, interior drainage has never been a problem, and a very minimal amount of storm sewers were constructed. Two small systems discharge into the Concho River in the downtown area and another system was recently constructed by the Texas Highway Department to drain a section of U.S. Highway 87. The vast majority of the City is drained by overland runoff, streets, and open ditches.

Insufficient data is available to effectively evaluate the magnitude of the pollution problem created by urban runoff in San Angelo, but the

problem definitely does exist. Unlike the metropolitan areas of Midland, Odessa and Big Springs in extreme West Texas where it is so dry that storm flows infiltrate into the stream bed or evaporate before reaching any perennial streams, thus creating no pollution problem downstream, the Concho River flowing through San Angelo is a river with flows affecting areas far downstream. The pollution problem caused by urban runoff is accentuated by the fact that the normal dilution effect that occurs during storm flows is greatly reduced because of impoundments upstream from the City which retain a major portion of all storm flows; therefore, the concentration of pollutants is higher.

The solution to the urban runoff problem is a very complex one and beyond the scope of this report. An in-depth study is needed to determine the exact magnitude of the problem and indicate possible structural as well as non-structural solutions to the problem.

Industrial Wastes.

Industries in the San Angelo area which could produce significant wastes are listed below:

| Industry | Nature | Comment |
|---|---|---|
| San Angelo Wool Process | Wool Processing | 1 |
| Producer's Auction Company | Livestock Sales | 2 |
| Premium Packing Company | Meat Processing | 3 |
| Handy Packing Company | Meat Processing | 3 |
| Armour & Company | Meat Processing | 4 |
| Wilson Packing | Meat Processing | 2 |
| Texas Tank Car Company | Railroad Car Repair | 5 |
| Gandy's Dairies, Inc. | Dairy Products | 4 |
| Ethicon, Inc. | Surgical Products | 4 |
| Mid-West Feed Yards | Sheep Feedlot | 2 |

| | | |
|---|---|---|
| Monarch Title Mfg., Inc. | Ceramic Wall Tile | 6 |
| San Angelo Feed Yards | Cattle Feedlot | 7 |
| San Angelo Rendering Company | Process Renderings | 7 |
| Veribest Cattle Feeders | Cattle Feedlot | 7 |

Comment Codes

| Code | Comment |
|---|---|
| 1 | Wastewater ponds connected tc city sewer. |
| 2 | Consultant study underway designed to eliminate surface runoff from facilities. |
| 3 | TWQB indicates no drainage problem evident and Industry connected to city sewer. |
| 4 | Industry connected to city sewer. |
| 5 | Occasional runoff problems indicated by TWQB. |
| 6 | Industry has occasional solid waste problem which TWQB indicates is handled satisfactorily. |
| 7 | Industry not within city limits. TWQB indicates operations are in compliance with waste control orders. |

Most of these industries discharge into San Angelo's sanitary sewer system with little, if any, pretreatment. Organic loadings are very high, especially from the meat processing industries, and a definite need exists for some type of pretreatment that will reduce the organic discharges to within the normal domestic range. Without pretreatment, the municipal treatment system will be subjected to shock loadings which could reduce the overall efficiency of the treatment process. The City has drafted a new industrial waste ordinance which it intends to enact; however, actual implementation is being deferred until it can be certain the ordinance will conform to Evironmental Protection Agency Policy.

Storm runoff from industrial sites can pose significant problems, especially in the case of cattle feedlots. Available information indicates that some feedlots in the area do not have adequate upstream drainage control and holding lagoons in accordance with TWQB Directive No. WQB-28. It would be difficult to determine the extent of pollution which may result from these feedlot operations. Previous reports indicate several other industries occasionally discharge wastewaters such as boiler water, washdown of yards, steam cleaning wastewater, etc., into off-property drainage ditches. San Angelo requires that all man-made waste, except washdown of service station drives, mineral oil and grease, and noxious substances, be discharged into the sanitary sewer system. When discharges into off-property ditches are found, the discharger is required to discontinue such discharge.

Solid Waste.

Solid waste disposal in San Angelo consists of a sanitary landfill. The landfill site is clay lined and protected from runoff so that it poses no water pollution problems at present. Solid waste from the sewage treatment plant is used for agricultural purposes on the City-owned irrigation farm. The waste from the surface water treatment plant is collected in a holding-evaporation pond adjacent to the plant site and poses no water pollution problem.

Waste Load Allocation.

The concept of waste load allocation is based on dividing the assimilative capacity of a particular stream among the waste producers in such a manner that the total waste load on the stream will not exceed its ability to renew and maintain itself at the desired quality level. Since the Concho River at San Angelo is not a perennial stream, any wastewater effluent discharged to a waterway becomes the stream flow under low flow conditions; and therefore, under a strict allocation methodology, stream quality standards would become effluent standards. For this reason, wastewater restrictions for San Angelo are and will remain effluent quality criteria. At present, the limiting effluent criteria for San Angelo is the TWQB requirement that effluent contain not more than 20 ppm $BOD_5$ and 20 ppm Total Suspended Solids, with at least 1.0 mg/l chlorine residual after 20 minute detention time.

Under PL 92-500, secondary treatment of wastewater will be adequate until 1983 at which time application of the "best practicable waste treatment

technology" will be required toward the ultimate goal of no discharge of pollutants. The plan to meet a wasteload allocation for San Angelo is therefore one which will meet the phased rational requirements of the law as described in Volume III, Technical Appendix.

## Municipal Wastewater Collection System.

### Existing Collection System.

The existing wastewater collection system for San Angelo is outlined on Plate CV-SA-2. The existing service area boundaries, the main trunk sewers, the sewage treatment plants, and irrigation farm are shown.

A detailed analysis of the San Angelo sanitary sewer trunk lines was made using information available in the "Report on Sewage and Waste Collection, Sewage Treatment, Related Water Quality for Tom Green County" by Freese, Nichols and Endress, Consulting Engineers. City officials have provided additional information updating the above-mentioned report showing improvements made and others planned to be made. The existing system was analyzed using the design criteria of 2000 gallons per acre per day and the results of this analysis is shown in Table SA-1. As can be seen in the table, several of the existing trunk sewers appear to be overloaded.

### Areas Utilizing Septic Tanks.

As best can be determined from the updated sewer map and other reports, there are no significant areas within the city limits of San Angelo where septic tanks are utilized for waste disposal. There are some scattered residences which do utilize septic tanks in the lightly developed northwest section of the City.

To the south of San Angelo in the area around Lake Nasworthy, septic tanks are utilized as the sole means of sewage disposal. This area is of primary concern since Lake Nasworthy is one of San Angelo's primary sources of municipal water supply. Soil conditions around the lake are not well suited to septic tanks and as development grows adjacent to the lake, a serious health problem could develop. This area should receive sewer service as soon as possible in order to eliminate the problem before it becomes too serious.

## TABLE SA-1

## ANALYSIS OF EXISTING TRUNK SEWERS

| From – To | Size (Inches) | Length (Feet) | Slope (%) | Existing Capacity (mgd) | Load (mgd) |
|---|---|---|---|---|---|
| **Line A** | | | | | |
| A - B | 10 | 1,800 | 0.20 | 0.64 | 0.28 |
| B - C | 10 | 1,050 | 0.62 | 1.12 | 0.41 |
| C - D | 10 | 250 | 1.04 | 1.48 | 0.44 |
| D - E | 10 | 300 | 0.66 | 1.15 | 0.44 |
| E - F | 10 | 4,300 | 0.20 | 0.64 | 0.44 |
| F - G | 10 | 3,300 | 0.20 | 0.64 | 0.42 |
| G - H | 10 | 1,100 | 0.70 | 1.20 | 0.53 |
| H - I | 10 | 800 | 0.69 | 1.19 | 0.71 |
| I - J | 10 | 350 | 0.20 | 0.64 | 0.74 |
| J - K | 10 | 600 | 0.59 | 1.10 | 0.74 |
| K - L | 10 | 800 | 0.20 | 0.64 | 0.85 |
| L - M | 12 | 1,050 | 0.29 | 1.24 | 0.85 |
| M - N | 12 | 600 | 0.20 | 1.03 | 1.04 |
| N - O | 8 | 500 | 1.01 | 0.79 | 2.04 |
| O - P | 10 | 300 | 0.27 | 0.74 | 2.12 |
| P - Q | 10 | 500 | 0.25 | 0.71 | 2.12 |
| Q - R | 12 | 400 | 0.20 | 1.03 | 2.22 |
| R - S | 15 | 1,700 | 0.18 | 1.78 | 2.35 |
| S - T | 18 | 1,200 | 0.14 | 2.57 | 6.18 |
| T - U | 18 | 3,000 | 0.14 | 2.57 | 8.85 |
| U - V | 21 | 1,000 | 0.095 | 3.2 | 8.85 |
| V - W | 21 | 1,700 | 0.095 | 3.2 | 9.07 |
| W - X | 2-18 | 1,900 | 0.11 | 13.55 | 10.57 |
| | 1-30 | | 0.10 | | |
| X - Y | 2-18 | 1,200 | 0.11 | 13.55 | 10.81 |
| | 1-30 | | 0.10 | | |
| Y-Z | 2-18 | 3,250 | 0.11 | 13.55 | 11.56 |
| | 1-30 | | 0.10 | | |
| Z - aa | 2-18 | 2,000 | 0.11 | 13.55 | 16.72 |
| | 1-30 | | 0.10 | | |
| aa - bb | 36 | 1,700 | 0.09 | 13.0 | 16.72 |
| bb - STP | 36 | 21,925 | 0.09 | 13.0 | 19.75 |
| **Line A-2** | | | | | |
| A - B | 15 | 3,800 | 0.20 | 1.88 | 0.15 |
| B - C | 15 | 1,600 | 0.20 | 1.88 | 0.15 |
| C - D | 15 | 1,200 | 0.22 | 1.95 | 0.15 |
| D - E | 15 | 350 | 0.57 | 3.2 | 0.15 |
| E - F | 15 | 300 | 0.27 | 2.18 | 0.15 |
| F - G | 15 | 4,750 | 0.20 | 1.88 | 0.15 |
| G - H | 15 | 2,500 | 0.20 | 1.88 | 0.23 |
| H - I | 15 | 2,350 | 0.20 | 1.88 | 2.49 |
| I - J | 12 | 400 | 0.14 | 0.86 | 2.49 |
| J - K | 12 | 1,000 | 0.14 | 0.86 | 2.95 |
| K - Line A | 15 | 7,300 | 0.20 | 1.88 | 3.02 |
| **Line A-2A** | | | | | |
| A - B | 12 | 1,850 | 0.20 | 1.03 | 0.83 |
| B - C | 12 | 3,800 | 0.20 | 1.03 | 1.26 |
| C - D | 12 | 7,650 | 0.20 | 1.03 | 1.82 |
| D - E | 12 | 500 | 1.20 | 2.54 | 1.82 |
| E - F | 12 | 900 | 1.00 | 2.30 | 2.12 |

## TABLE SA-1 (Cont'd.)

| From – To | Size (Inches) | Length (Feet) | Slope (%) | Existing Capacity (mgd) | Load (mgd) |
|---|---|---|---|---|---|
| **Line A-2A (Cont'd.)** | | | | | |
| F - G | 12 | 1,100 | 0.20 | 1.03 | 2.12 |
| G - Line A-2 | 12 | 2,350 | 0.20 | 1.03 | 2.16 |
| **Line A-3** | | | | | |
| A - B | 12 | 1,700 | 0.16 | 0.93 | 0.432 |
| B - C | 12 | 2,000 | 0.16 | 0.93 | 0.656 |
| C - D | 12 | 5,000 | 0.20 | 1.03 | 0.968 |
| D - E | 8 | 400 | 1.32 | 0.89 | 1.23 |
| E - F | 12 | 3,400 | 0.20 | 1.03 | 2.27 |
| F - G | 12 | 4,350 | 0.20 | 1.03 | 2.40 |
| G - H | 24 | 4,700 | 0.10 | 4.7 | 2.43 |
| H - Line A | 30 | 12,000 | 0.10 | 8.5 | 2.43 |
| **Line A-3A** | | | | | |
| A - B | 12 | 500 | 0.20 | 1.03 | 0.056 |
| B - C | 12 | 1,250 | 0.20 | 1.03 | 0.125 |
| C - D | 12 | 3,800 | 0.20 | 1.03 | 0.450 |
| D - Line 3-A | 12 | 2,150 | 0.20 | 1.03 | 0.585 |
| **Line A-3B** | | | | | |
| A - B | 10 | 2,300 | 0.5 | 1.0 | 0.39 |
| B - C | 12 | 2,000 | 0.2 | 1.0 | 0.45 |
| C - D | 15 | 1,900 | 1.5 | 5.0 | 0.45 |
| D - Line A-3 | 18 | 300 | 0.1 | 2.15 | 0.45 |
| **Line A-4** | | | | | |
| A - B | 8 | 1,000 | 0.20 | 0.35 | 0.036 |
| B - C | 8 | 800 | 0.67 | 0.64 | 0.184 |
| C - D | 8 | 2,700 | 0.20 | 0.35 | 0.367 |
| D - E | 12 | 1,750 | 0.14 | 0.86 | 0.547 |
| E - Line A | 12 | 2,550 | 0.14 | 0.86 | 0.674 |
| **Line A-5** | | | | | |
| A - B | 12 | 5,300 | 0.20 | 1.03 | 0.33 |
| B - C | 15 | 2,200 | 0.10 | 1.32 | 0.764 |
| C - D | 15 | 5,400 | 0.10 | 1.32 | 0.764 |
| D - E | 15 | 1,850 | 0.10 | 1.32 | 1.25 |
| E - F | 15 | 1,750 | 0.10 | 1.32 | 1.38 |
| F - Line A | 15 | 900 | 0.10 | 1.32 | 2.05 |
| **Line A-5A** | | | | | |
| A - B | 12 | 1,700 | 0.20 | 1.03 | 0.248 |
| B - C | 12 | 1,100 | 0.20 | 1.03 | 0.326 |
| C - D | 12 | 1,100 | 0.42 | 1.50 | 0.362 |
| D - E | 12 | 1,300 | 0.20 | 1.03 | 0.486 |
| E - Line A-5 | 12 | 400 | 0.88 | 2.15 | 0.486 |
| **Line A-7** | | | | | |
| A - B | 12 | 3,850 | 0.14 | 0.86 | 0.34 |
| B - C | 12 | 4,350 | 0.14 | 0.86 | 0.51 |
| C - Line A | 12 | 550 | 0.14 | 0.86 | 0.64 |

TABLE SA-1 (Cont'd.)

| From — To | Size (Inches) | Length (Feet) | Slope (%) | Existing Capacity (mgd) | Load (mgd) |
|---|---|---|---|---|---|
| **Line A-8** | | | | | |
| A - B | 10 | 250 | 0.25 | 0.71 | 0.26 |
| B - C | 12 | 1,200 | 0.20 | 1.03 | 0.84 |
| C - D | 12 | 600 | 0.25 | 1.16 | 0.84 |
| D - E | 10 | 600 | 0.72 | 1.20 | 0.99 |
| E - F | 12 | 800 | 0.20 | 1.03 | 0.99 |
| F - G | 8 | 400 | 2.00 | 1.11 | 0.99 |
| G - H | 12 | 900 | 0.40 | 1.47 | 1.08 |
| H - I | 12 | 300 | 0.45 | 1.54 | 1.08 |
| I - J | 12 | 200 | 0.94 | 2.23 | 1.25 |
| J - K | 15 | 500 | 0.57 | 3.15 | 1.44 |
| K - L | 12 | 200 | 0.75 | 2.00 | 1.44 |
| L - Line A | 18 | 1,500 | 0.11 | 2.27 | 1.76 |
| **Line A-9** | | | | | |
| A - B | 12 | 3,600 | 0.10 | 0.74 | 0.19 |
| B - C | 8 | 500 | — | — | 0.19 |
| C - D | 12 | 2,300 | 0.10 | 0.74 | 0.23 |
| D - E | 8 | 1,750 | 0.20 | 0.35 | 0.41 |
| E - F | 6 | 1,100 | 0.50 | 0.26 | 0.622 |
| F - G | 12 | 2,250 | 0.10 | 1.29 | 0.99 |
| | 8 | — | 0.50 | — | — |
| G - H | 8 | 3,650 | 0.30 | 1.21 | 1.59 |
| | 10 | — | — | — | — |
| H - I | 15 | 1,200 | — | — | 1.76 |
| I - Line A | 15 | 800 | — | — | 2.18 |
| **Line A-11** | | | | | |
| A - B | 12 | 1,850 | 0.20 | 1.03 | 0.63 |
| B - C | 12 | 4,950 | 0.20 | 1.03 | 0.78 |
| C - D | 12 | 1,600 | 0.30 | 1.27 | 2.06 |
| D - E | 12 | 4,050 | 0.30 | 1.27 | 2.15 |
| E - Line A | 12 | 700 | 0.30 | 1.27 | 3.66 |
| **Line A-12** | | | | | |
| A - B | 8 | 700 | 1.08 | 0.82 | 0.356 |
| B - C | 8 | 400 | 0.30 | 0.43 | 0.356 |
| C - D | 8 | 300 | 1.23 | 0.87 | 0.61 |
| D - E | 8 | 400 | 1.45 | 0.95 | 0.66 |
| E - F | 8 | 400 | 0.50 | 0.55 | 0.72 |
| F - G | 8 | 800 | 0.40 | 0.50 | 0.78 |
| G - H | 8 | 300 | 0.50 | 0.55 | 0.87 |
| H - I | 8 | 400 | 0.80 | 0.70 | 0.87 |
| I - J | 8 | 400 | 1.45 | 0.95 | 0.87 |
| J - K | 8 | 1,400 | 0.40 | 0.495 | 1.02 |
| K - Line A | 6 | 700 | 1.76 | 0.485 | 1.02 |

Proposed Collection System.

The proposed collection system improvements for the City of San Angelo are shown on Plate CV-SA-2. The improvements were phased as follows: immediate, 1980, 1990, and 2020. In the following paragraphs a detailed discussion of the proposed improvements is presented along with the cost of each phase.

Immediate. The main trunk line, Line A, is overloaded from Bell Street to the existing sewage treatment plant and should be paralleled with a 48-inch line which will be adequate until 1990. The line is also overloaded in the reach between 12th Street and where Line A crosses the North Concho River just below the intersection of Magdalene Street and Concho Avenue, and requires a parallel line ranging in size from 15 inches to 27 inches. One other relief line, an 8-inch line, is necessary from 14th Street to Shelton Street.

Line A-2 is in need of a relief from Ellis Street to Line A as shown in Plate CV-SA-2. Line A-2A, a sublateral of Line A-2, is overloaded throughout. To alleviate this condition, a 15-inch bypass line should be constructed along 36th Street between Line A-2A and Line A-2 and an 8-inch relief line should be constructed parallel to Line A-2A along La Follette Street as indicated on the referenced plate.

Line A-3 is heavily overloaded and a 27-inch relief line in parallel is proposed, from Knickerbocker Road to Ben Ficklin Road.

The upper portion of Line A-9 is presently overloaded, and it is proposed to divert the upper portion of Line A-9's service area to Line A-5 which is under capacity at the present time. A portion of the relief line has already been constructed as shown in Plate CV-SA-2.

Line A-12 is in need of relief from 23rd Street to Line A. An 8-inch line is proposed to parallel Line A-12 to correct this situation.

The final immediate improvement need is a 15-inch and 24-inch line to relieve the upper portion of Line A-11. The 24-inch section will not be fully utilized at the present time but will be used in later phases.

The total cost of all immediate improvements as described above are summarized below by line size, with engineering and contingencies included in the final total.

Immediate Improvements

| | | |
|---|---|---|
| 8" - 10,600' @ $ 9.50/ft. | = | $100,700 |
| 10" - 2,000' @ $12.00/ft. | = | 24,000 |
| 12" - 2,600' @ $15.00/ft. | = | 39,000 |
| 15" - 12,600' @ $19.30/ft. | = | 243,180 |
| 18" - 1,200' @ $23.50/ft. | = | 28,200 |
| 24" - 5,000' @ $32.20/ft. | = | 161,000 |
| 27" - 12,000' @ $37.20/ft. | = | 446,400 |
| 48" - 30,400' @ $56.90/ft. | = | 1,729,760 |
| Subtotal | | $2,772,240 |
| Engineering and Contingencies | | 460,190 |
| Total | | $3,232,430 |

1980. By 1980, a number of collection lines will be needed to serve the projected development south of the City. The 27-inch relief line proposed under immediate improvements parallel to Line A-3 should be extended along Red Arroyo and then change to a 24-inch line south along a natural drainage channel to Loop 306. Along the lower portion of Line A-3 from Line A to Ben Ficklin Road a 42-inch relief line will be needed by 1980. At Ben Ficklin Road, the proposed trunk line turns south to the South Concho River and then along the South Concho River and around Lake Nasworthy to serve the existing and proposed development around the lake. A 1.3-mgd pump station should be constructed on the south side of Lake Nasworthy to pump waste from the existing development across the lake at Knickerbocker Road and into the proposed trunk line.

The total cost of all improvements between the immediate improvements and 1980, as described above, are summarized below by line size with engineering and contingencies included in the final cost.

Improvements to 1980

| | | |
|---|---|---|
| 12" - 4,000' @ $15.00/ft. | = | $ 60,000 |
| 15" - 7,600' @ $19.30/ft. | = | 146,670 |
| 18" - 3,200' @ $23.50/ft. | = | 75,200 |
| 24" - 23,200' @ $32.20/ft. | = | 747,040 |
| 27" - 22,800' @ $37.20/ft. | = | 848,160 |
| 36" - 13,800' @ $42.70/ft. | = | 589,260 |
| 42" - 15,000' @ $51.80/ft. | = | 777,000 |
| Subtotal | | 3,243,340 |
| 8" F.M. - 1,200' @ $6.00/ft. | | 7,200 |
| 1.3 mgd Lift Station | | 85,750 |
| Subtotal | | 3,336,290 |
| Engineering and Contingencies | | 553,820 |
| Total | | $3,890,110 |

1990. Two major trunk line extensions are projected for 1990. An 18-inch trunk is proposed along the old railroad right-of-way just north of the North Concho River between 14th Street and Lake Drive, at which point the line continues north as a 15-inch line to serve the project development as shown on Plate CV-SA-2.

The second major extension is in the south portion of the City along Red Arroyo. The 27-inch trunk proposed for 1980 is proposed to be extended as an 18-inch line along Red Arroyo to approximately halfway between the proposed East-West Freeway and Farm Road 853, at which point the system splits and continues as two 12-inch lines to serve the projected development between U.S. 67 and Farm Road 853.

Several other short extensions are proposed to serve additional areas at projected 1990 development. The total cost of all improvements from the 1980 phase to 1990 are summarized below by line size, with engineering and contingencies included in the final cost.

Improvements to 1990

| | |
|---|---|
| 12" - 32,200' @ $15.00/ft. = | $483,000 |
| 15" - 10,400' @ $19.30/ft. = | 200,720 |
| 18" - 22,800' @ $23.50/ft. = | 535,800 |
| 24" - 2,000' @ $32.20/ft. = | 64,400 |
| 6"F.M. 2,200' @ $ 5.00/ft. = | 11,000 |
| Lift Station (0.426 mgd) = | 40,000 |
| Subtotal | 1,334,920 |
| Engineering and Contingencies | 229,600 |
| Total | $1,564,520 |

2020. Several major trunk line systems are projected to be constructed by 2020, first of which is an additional line in parallel to the existing 36-inch line to the sewage treatment plant east of the City. It is to consist of 10,600 feet of 42-inch line plus 15,600 feet of 48-inch line.

A new system is proposed to serve the projected development east of San Angelo along Loop 306. The total cost of the system is estimated to be $978,840. A second system is proposed to parallel the existing Line A-2 to serve the projected 2020 development south of Farm to Market Road 2105 and north at the Gulf, Colorado and Santa Fe Railroad running through town. This system is estimated to cost $1,133,940. This cost, as with the first system mentioned, does not include engineering and contingencies.

One other area of major importance is the existing municipal airport. Substantial industrial development is projected in this area, and it is proposed that the existing Mathis Field Sewage Treatment Plant be abandoned at this time and the area be served by the San Angelo collection system.

Other lines are proposed as shown on Plate CV-SA-2 and are included in the cost estimates listed below. The total cost of all collection system improvements to be completed after 1990 and before 2020 are summarized by line size, with engineering and contingencies included in the final cost.

Improvements to 2020

| | |
|---|---|
| 10" - 2,600' @ $12.00/ft. = | $ 31,200 |
| 12" - 24,400' @ $15.00/ft. = | 366,000 |
| 15" - 22,800' @ $19.30/ft. = | 440,040 |
| 18" - 5,400' @ $23.50/ft. = | 126,900 |
| 21" - 19,600' @ $28.00/ft. = | 548,800 |
| 24" - 10,800' @ $32.20/ft. = | 347,760 |
| 27" - 19,600' @ $37.20/ft. = | 729,120 |
| 42" - 10,600' @ $51.80/ft. = | 549,080 |
| 48" - 15,600' @ $56.90/ft. = | 887,640 |
| Subtotal | $4,026,540 |
| Engineering and Contingencies | 664,380 |
| Total | $4,690,920 |

A summary of the phases and the total cost for the proposed collection system is shown below.

| Phase | Cost |
|---|---|
| Immediate | $3,232,430 |
| 1980 | 3,890,100 |
| 1990 | 1,564,520 |
| 2020 | 4,690,920 |
| Total | $13,377,970 |

## Municipal Wastewater Treatment System.

### Existing Wastewater Treatment System.

San Angelo's main sewage treatment facility is located on the north bank of the Concho River approximately 4,500 feet downstream from Farm to Market Road 380 as shown on Plate CV-SA-2. A second, smaller facility serving the municipal airport is located just south of Mathis Field, also shown on the above-referenced Plate. This plant was originally built during World War II to serve a population of about 5,000 people. The plant is a Hays Process system followed by a large lagoon. The present flow into the plant is so small that the facilities

are acting for the most part as evaporation basins. It is proposed that the airport plant be ultimately phased out when development is complete in the area and be connected to the San Angelo collection system.

The existing City of San Angelo main wastewater treatment plant utilizes primary treatment, including approximately 65 acres of holding ponds, followed by broad irrigation on approximately 738 acres of cropland owned by the City. A preliminary study by Freese, Nichols and Endress, Consulting Engineers, for the City of San Angelo proposes to upgrade the existing plant to a secondary treatment facility using the activated sludge process. These proposed treatment units would also have a design capacity of 7.36 mgd.

The "Concho Valley Council of Governments Report on Sewage and Waste Collection, Sewage Treatment, (and) Related Water Quality" for Tom Green County, also prepared by Freese, Nichols and Endress, reports that a flow contribution design criteria of 75 gallons per capita is representative of the flow contribution for existing and proposed conditions in the San Angelo area with respect to sewage treatment facilities. Therefore, this criteria will be utilized for San Angelo in this report for evaluation of existing facilities and proposed expansions thereto. Using this criteria, the capacity of the existing plant (7.36 mgd) would be adequate to treat the sewage from a population of 98,100. Based on the population projections supplied by the Texas Water Development Board, this capacity would be adequate until year 2000. At that time, a 2.0-mgd expansion to the treatment plant would provide adequate capacity until year 2020. A detailed description of the components of the main treatment facility and the status of performance, operation and maintenance is presented in Appendix AB-30 of this section.

The existing City irrigation site is underlain by soils of the Knippa-Frio and Rowena-Mereta associations. Both associations are characterized by calcareous clays and clay loams whose permeabilities range from 0.2 to 0.63 inches per hour.

A review of the general soil types in Tom Green County indicated that there were no suitable sites where the rapid infiltration method of land disposal would be feasible. Thus, this method of land disposal will not be considered with any of the alternative methods of treatment presented for the San Angelo metropolitan area.

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
SEP 73

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2 OF 4
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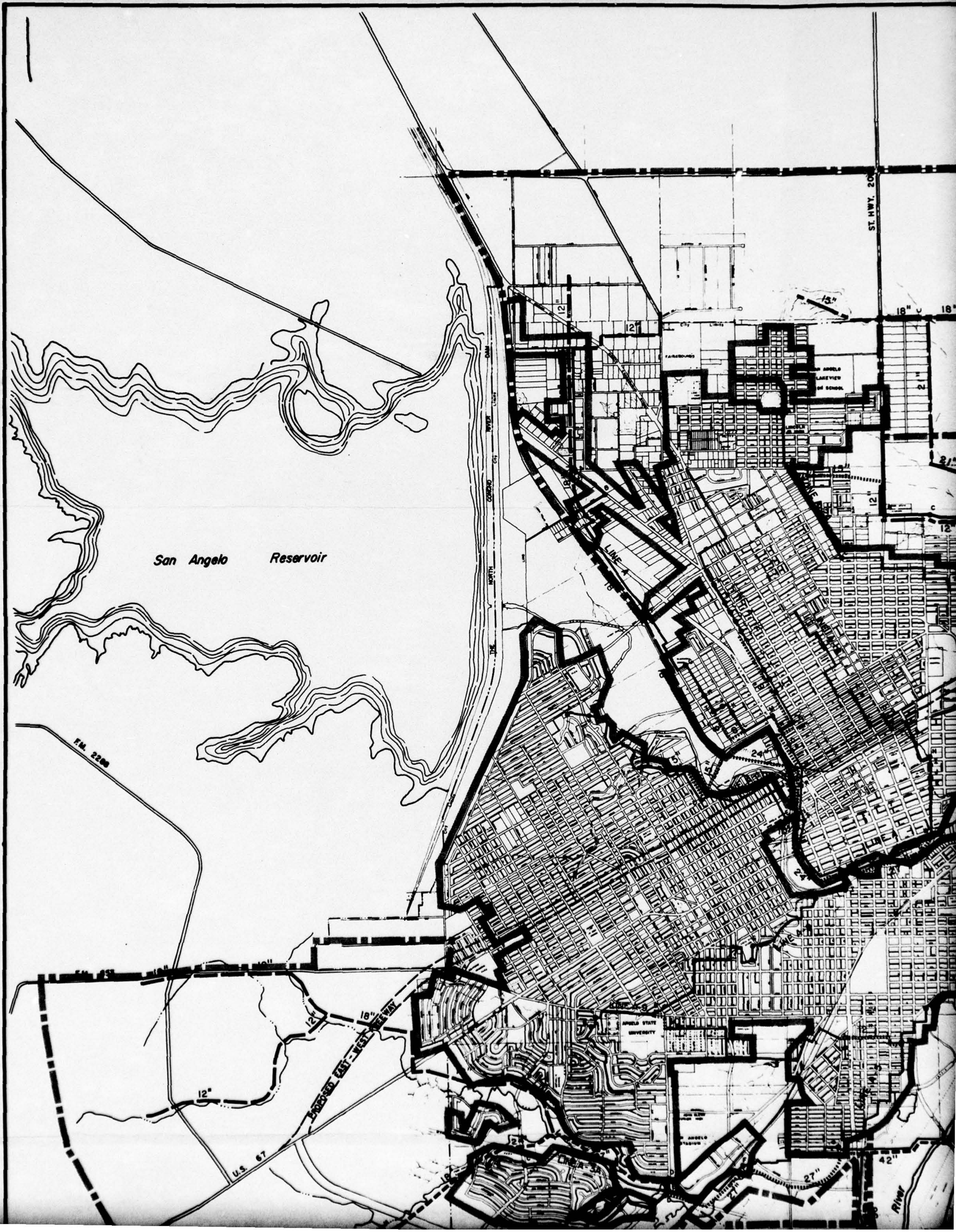
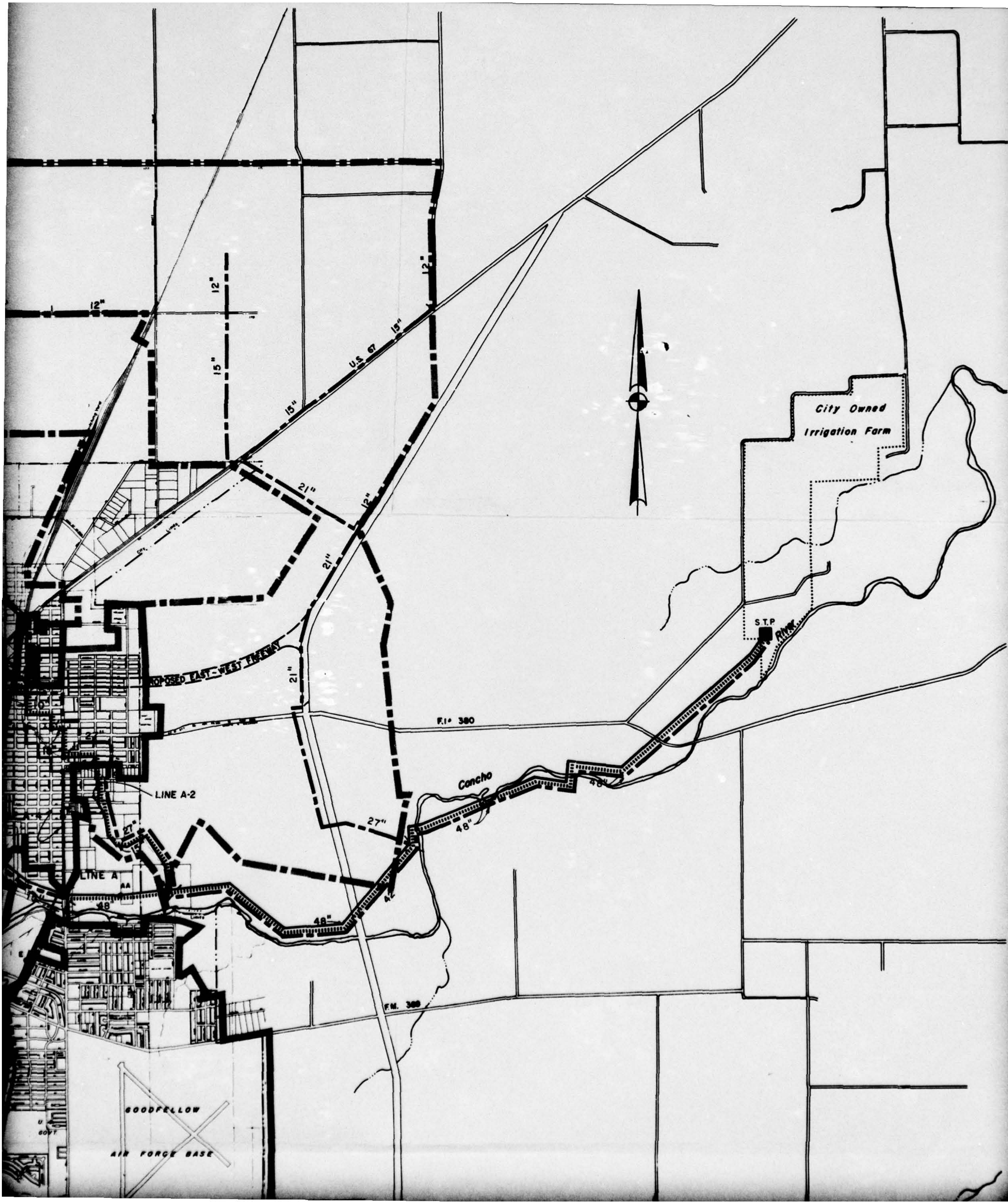
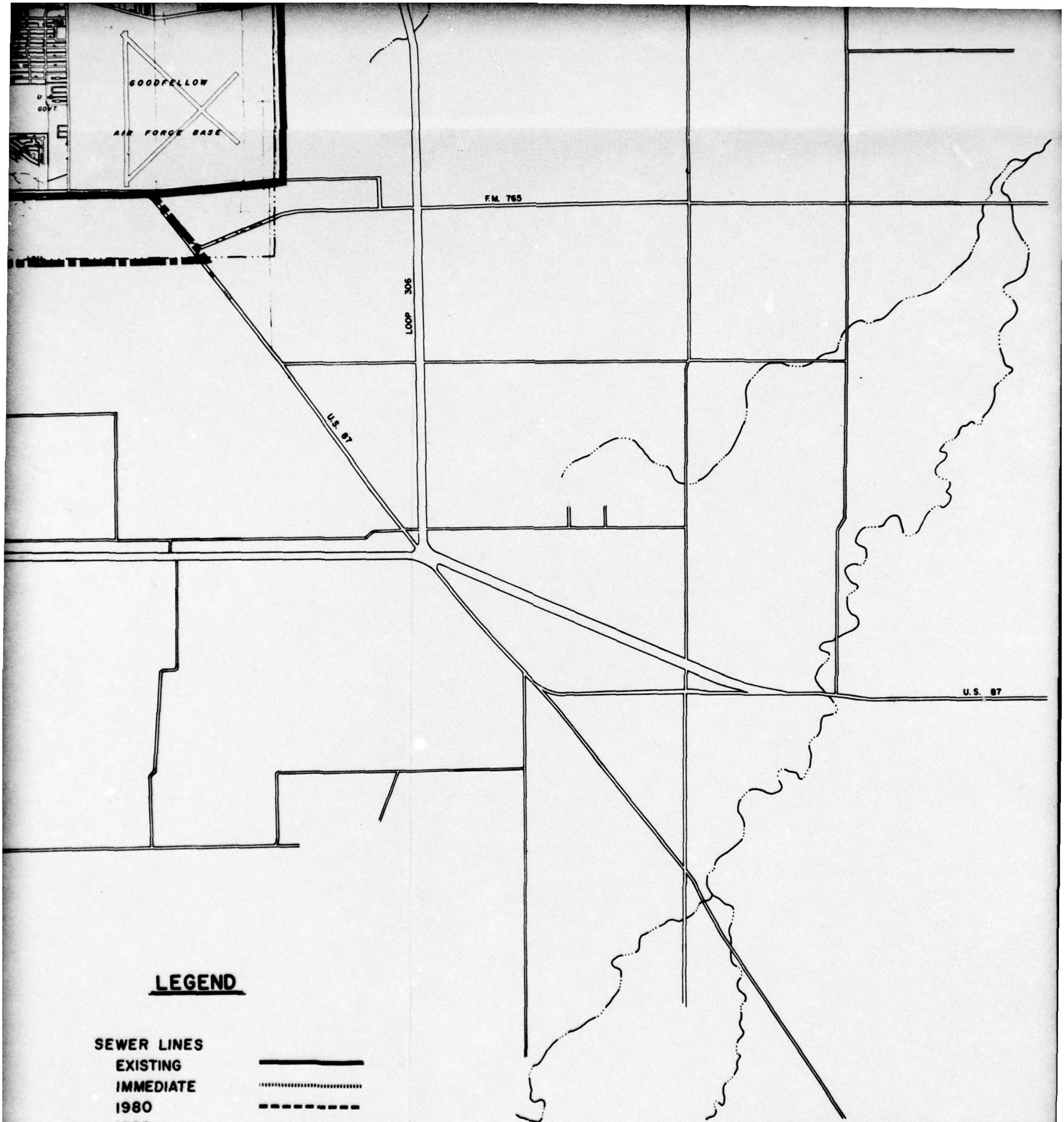


San Angelo
Reservoir
F.M. 2288
ST. HWY. 20
NORTH CONCHO RIVER
LINE 4
ANGELO STATE UNIVERSITY
PROPOSED EAST - WEST FREEWAY
U.S. 67
12"
18"
21"
24"
27"
42"
River



12"
15"
U.S. 67
21"
27"
48"
City Owned
Irrigation Farm
S.T.P.
River
Concho
F.M. 380
PROPOSED EAST-WEST FREEWAY
LINE A-2
LINE A
GOODFELLOW
AIR FORCE BASE


PROPOSED EAST - WEST
ANGELO STATE UNIVERSITY
SAN ANGELO STADIUM
U.S. 67
12"
15"
18"
24"
27"
36"
42"
6" FM
LINE A
LOOP 306
AT & SF
Concho
South
River
Nasworthy
Lake
8" FM
KNICKERBOCKER RD.
U.S. 277
Twin Buttes Reservoir
MUNICIPAL AIRPORT
(MATHIS FIELD)
S.T.P.
PANHANDLE and SANTA FE
South Concho River
Pecan Creek
3




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

**WASTEWATER MANAGEMENT STUDY**
**COLORADO RIVER & TRIBUTARIES, TEXAS**

SAN ANGELO
SANITARY SEWER

TURNER COLLIE AND BRADEN, INC. - HOUSTON / PORT ARTHUR

SCALE: 1" = 4000'
PLATE: CV-SA-2

The spray irrigation method of land disposal appears to be the most feasible alternative which can be considered for this study area. Since spray irrigation is proposed herein to be practiced on a year-round basis, conditions for both summer and winter must be examined to determine the limiting condition. In general, the application rate can be expressed as the sum of the gross evaporation, the gross transpiration, and the rate of infiltration less the gross rainfall. For planning purposes, the potential evapotranspiration can be expressed as the evaporation as measured in standard 4-foot Class A Weather Bureau Evaporation pans. For the purposes of this study, the net reservoir evaporation rates as given in "Monthly Reservoir Evaporation Rates for Texas, 1940 and 1965," TWDB Report 64 were assumed to be the gross evapotranspiration less the gross rainfall. The average net evaporation rates for the San Angelo area are presented below:

Net Reservoir Evaporation Rates
(Feet per Month)

| Summer Months | | Winter Months | |
|---|---|---|---|
| April | 0.425 | October | 0.407 |
| May | 0.437 | November | 0.324 |
| June | 0.665 | December | 0.221 |
| July | 0.807 | January | 0.192 |
| August | 0.824 | February | 0.212 |
| September | 0.584 | March | 0.386 |

Summer (average) = 0.624 ft./mo.
Winter (average) = 0.29 ft./mo.

The winter and summer months division was arbitrarily chosen after reviewing each month's evaporation rate.

Assuming a one-day-per-week application of effluent followed by a six-day renovation period, it is assumed that there is an excess daily application rate equal to the weekly evaporation rate as follows:

Summer excess application rate = (0.624 ft./mo.) (12 mo./yr.) (yr./52 wks.) (12 in./ft.)
= 1.73 inches/week

$$\text{Winter excess application rate} = (0.29 \text{ ft./mo.})(12 \text{ mo./yr.})(\text{yr./52 wks.})(12 \text{ in./ft.}) = 0.80 \text{ inches/week}$$

Assuming the operation of the land disposal site will be during a regular eight-hour working day and choosing the lower permeability (0.2 in./hr.) for the soils in the site area, infiltration would account for 1.6 inches per week.

From the above calculations, the summer and winter application rates for San Angelo are estimated to be as follows:

$$\text{Summer} = 1.73 + 1.6 = 3.33 \text{ inches/week}$$

$$\text{Winter} = 0.80 + 1.6 = 2.40 \text{ inches/week}$$

Thus, the winter application rate is the limiting value and will be used for San Angelo in evaluating and proposing spray irrigation land requirements.

The existing 640-acre disposal site was evaluated and found to be capable of serving approximately 79,400 people, utilizing the flow contribution of 75 gallons per capita per day. Thus, the existing disposal site is apparently adequate to renovate the secondary effluent from San Angelo's population until about 1985. At that time, an expansion of 328 acres to the land disposal site, using spray irrigation, would be required to provide adequate capacity until year 2020. During rainy periods of the year, wastewater application rates and precipitation frequently exceed percolation and evaporation rates, and ponding occurs. For this reason, the City may wish to increase the area of the existing site. However, it is recommended the City evaluate the cost comparison between the additional area and increased holding pond capacity which would allow greater operational flexibility.

If the four existing holding ponds covering about 65 acres were assumed to be four feet deep, the volume of the ponds would then be 260 acre-feet, or 11,325,600 cubic feet.

The required volume of ponds to hold the year 2020 average sewage flow of 9,318,750 gpd from the City of San Angelo for seven days would be 8,720,755 cubic feet. Thus, based on the above assumptions, the existing holding ponds should be adequate to serve the City throughout the study period.

## Proposed Wastewater Treatment Facility Alternatives.

This portion of the report describes the different alternatives for sewage treatment in the San Angelo metropolitan area. All alternatives present plans for meeting the requirements of PL 92-500. This requirement consists of providing, as a minimum, level of secondary treatment by 1977, best practicable waste treatment technology by 1983, and achieving a no-discharge of pollutants status by 1985. These alternatives include biological, physical/chemical, and land disposal processes, together with combinations of these three types of treatment. The estimated capital costs and annual costs, including operation and maintenance, are also presented for all alternatives.

The final plan presented is for decentralized treatment as an alternative to expansion of the lengthy collection system to the present facility.

Prior to presentation of the proposed wastewater treatment facility alternatives, it should be noted that proposed collection system costs are common to each alternative and these costs are therefore repeated for all alternatives.

For San Angelo, a total of nine alternative wastewater treatment schemes were investigated during the conduct of this study. These nine alternatives were evaluated and three alternatives were selected as the most viable alternatives. All of the nine alternatives will meet the treatment requirements of PL 92-500. A discussion of the three most viable alternatives is presented, followed by a less detailed discussion of the six remaining alternatives.

### Alternative 1.

Alternative 1 includes modification and expansion of the existing treatment facilities by 1975 to a 7.36-mgd activated sludge plant capable of providing conventional secondary treatment. The existing infiltration method of land disposal would be utilized for irrigation of City-owned cropland. By 1985, an additional 328 acres would be required to increase the capacity of the land disposal system. Due to its greater operational efficiency, the spray-irrigation method of land disposal is proposed for these additional 328 acres. By the year 2000, a 2.0-mgd expansion of the secondary treatment system would be required.

## 1975 CAPITAL COSTS

| Description | Estimated Cost |
|---|---|
| Bar Screens | $ 40,000 |
| Main Lift Pumps & Starters | 25,000 |
| Grit Separation | 25,000 |
| Primary Clarifiers | 35,000 |
| Primary Sludge Pumps | 25,000 |
| Skimmings Removal | 10,000 |
| Aerators & Eff. Weirs - 50 HP @ $15,000 ea. | 130,000 |
| Final Clarifiers | 50,000 |
| Return & Waste Act. Sludge Pumps (2) | 30,000 |
| Aerobic Digestors | 50,000 |
| Air Blowers | 20,000 |
| Irrigation Lift Pump | 45,000 |
| Motor Starters | 40,000 |
| Miscellaneous Pumps | 30,000 |
| Var. Speed Motor Control | 25,000 |
| Remove & Salvage Existing Piping | 40,000 |
| Laboratory Equipment & Supplies | 25,000 |
| Instrumentation & Metering | 30,000 |
| Standby, Generator Installation | 60,000 |
| Installation of Equipment | 80,000 |
| Demolition & Salvaging | 90,000 |
| Earthwork 25,000 CY @ $2.00 | 55,000 |
| Landscaping & Yardwork | 20,000 |
| Roads and Fencing | 45,000 |
| Concrete 3,100 CY @ $115.00 | 372,000 |
| Pipework | 100,000 |
| Valves & Gates | 50,000 |
| Administration & Control Building | 100,000 |
| Renovation Existing Buildings | 15,000 |
| Painting | 20,000 |
| Miscellaneous Metal | 15,000 |
| Electrical | 40,000 |
| Sludge Disposal | 50,000 |
| Subtotal | $1,787,000 |
| Engineering & Contingencies | 363,000 |
| Total | $2,150,000 |

1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (7.36 mgd) | $204,000 |

1985 Capital Costs

| Description | Estimated Cost |
|---|---|
| Land 328 acres at $1,000 per acre | $328,000 |
| Spray irrigation equipment | 266,400 |
| Effluent pumps | 10,000 |
| Distribution line | 15,000 |
| Subtotal | 619,400 |
| Engineering and Contingencies | 50,200 |
| TOTAL | $669,600 |

1985 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (7.36 mgd) | $204,000 |
| Spray Irrigation System (328-Acre Expansion) | 21,900 |
| TOTAL | $225,900 |

2000 Capital Costs

| Description | Estimated Cost |
|---|---|
| 2.0 mgd Expansion to Secondary Treatment Facilities (9.36 mgd) | $900,000 |
| Engineering and Contingencies | 158,400 |
| TOTAL | $1,058,400 |

2000 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (9.36 mgd) | $252,800 |
| Spray Irrigation Facilities | 21,900 |
| TOTAL | $274,700 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of Alternative 1 is presented in Appendix B of this section. Alternative 1 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 2.

Alternative 2 includes modification and expansion of the existing treatment facilities by 1975 to a 7.36-mgd activated sludge plant capable of providing conventional secondary treatment. Also, by 1975, biological tertiary treatment would be initiated. This tertiary treatment includes nitrification, denitrification, filtration, activated carbon treatment, chlorination and aeration of the effluent. Both secondary and tertiary improvements would probably occur simultaneously. The effluent would be of acceptable quality for reuse or could be discharged. Due to continued development, a 2.0-mgd expansion of the facilities would be required by the year 2000. The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

| Description | Estimated Cost |
| --- | --- |
| Secondary Treatment Facilities (7.36 mgd) | $1,787,000 |
| Tertiary Treatment Facilities (7.36 mgd) | 4,500,000 |
| Subtotal | 6,287,000 |
| Engineering and Contingencies | 1,019,750 |
| TOTAL | $7,306,750 |

1975 Annual O & M Cost

| Description | Estimated Cost |
| --- | --- |
| Combined Facilities (7.36 mgd) | $ 859,650 |

**2000 Capital Costs**

| Description | Estimated Cost |
|---|---|
| Expand facilities by 2.0 mgd (9.36 mgd) | $1,600,000 |
| Engineering and Contingencies | 281,600 |
| TOTAL | $1,881,600 |

**2000 Annual O & M Cost**

| Description | Estimated Cost |
|---|---|
| Combined facilities (9.36 mgd) | $ 990,750 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Captial Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of Alternative 2 is presented in Appendix B of this section. Alternative 2 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

**Alternative 3.**

Alternative 3 includes modification and expansion of the existing treatment facilities by 1975 to a 7.36-mgd activated sludge plant

capable of conventional secondary treatment. The existing infiltration method of land disposal will be utilized for irrigation of City-owned cropland. By 1985, an additional 395 acres would be required to increase the capacity of the land disposal system. The overland runoff method of land disposal would be utilized on these additional 395 acres. Due to continued development, a 2.0-mgd expansion of the secondary treatment system will be required by the year 2020. The initial (1975) secondary treatment improvements are the same as those presented for Alternative 1, and therefore are shown as a total in the following cost breakdown by phases.

1975 Capital Costs

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (7.36 mgd) | $1,787,000 |
| Engineering and Contingencies | 363,000 |
| TOTAL | $2,150,000 |

1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (7.36 mgd) | $ 204,000 |

1985 Capital Costs

| Description | Estimated Cost |
|---|---|
| Expand Land Disposal Facilities | |
| Land - 395 acres at $1,000 per acre | $ 395,000 |
| Irrigation equipment | 330,000 |
| Effluent pumps | 10,000 |
| Distribution line | 15,000 |
| Subtotal | 750,000 |
| Engineering and Contingencies | 59,250 |
| TOTAL | $ 809,250 |

### 1985 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (7. 36 mgd) | $ 204,000 |
| Overland runoff irrigation system (395 Acre Expansion) | 26,650 |
| TOTAL | $ 230,650 |

### 2000 Capital Costs

| Description | Estimated Cost |
|---|---|
| Expansion to Secondary Treatment Facilities (2. 0 mgd) | $ 900,000 |
| Engineering and Contingencies | 158,400 |
| TOTAL | $1,058,400 |

### 2000 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary Treatment Facilities (9. 36 mgd) | $ 252,800 |
| Irrigation Facilities (395-Acre Expansion | 26,650 |
| TOTAL | $ 279,450 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of Alternative 3 is presented in Appendix B of this section. Alternative 3 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

The aforementioned 3 alternatives were selected as the most viable, cost-effective alternatives. The additional six alternatives investigated, but not selected for further refinement, are presented below. All of these alternatives will meet the requirements of PL 92-500 and were considered for immediate (1975) implementation.

Alternative 4.

Alternative 4 includes modification and expansion of the existing treatment facilities by 1975 to a 7.36-mgd secondary treatment plant utilizing the trickling filter process. Also by 1975, the secondary treatment facilities would be upgraded in order to provide full tertiary treatment using the trickling filter to achieve nitrification. The improvement would also include denitrification, filtration, activated carbon treatment, chlorination and aeration of the effluent. Due to continued development a 2.0-mgd expansion of the secondary and tertiary treatment facilities would be required by 1990.

The estimated costs of this alternative, by phases, is presented below.

### 1975 Capital Costs

| Description | Estimated Cost |
|---|---|
| Improve existing secondary facilities (7.36 mgd) | $ 1,787,000 |
| Upgrade secondary treatment to tertiary treatment (7.36 mgd) | 8,500,000 |
| Subtotal | 10,287,000 |
| Engineering and Contingencies | 1,646,000 |
| TOTAL | $11,933,000 |

### 1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Combined facilities (7.36 mgd) | $ 698,500 |

### 2000 Capital Costs

| Description | Estimated Cost |
|---|---|
| 2.0 mgd expansion of secondary & tertiary facilities (9.36 mgd) | $ 4,200,000 |
| Engineering and Contingencies | 688,800 |
| TOTAL | $ 4,888,800 |

### 2000 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Combined facilities (9.36 mgd) | $ 854,100 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of Alternative 4 is presented in Appendix B of this section.

Alternative 4 was not selected for further refinement because:

(a) the activated sludge process is more flexible and more efficient,

(b) the City has expressed a desire to utilize the activated sludge process, and

(c) this alternative was not one of the most cost effective alternatives.

Alternative 5.

Alternative 5 includes construction of a new 7.36-mgd physical-chemical plant by 1975 to provide conventional secondary treatment and full tertiary treatment. This treatment scheme includes high lime treatment, neutralization, ammonia stripping, denitrification, activated carbon treatment, chlorination and aeration of the effluent. It will be assumed for this alternative that a complete new facility would be constructed, although a number of existing components could probably be salvaged. Also, due to continued development, a 2.0-mgd expansion of these facilities would be needed by the year 2000. The estimated costs of this alternative, by phases, are presented below.

## 1975 Capital Costs

| Description | Estimated Cost |
|---|---|
| Construct new facility (7.36 mgd) | $ 4,200,000 |
| Engineering and Contingencies | 684,600 |
| TOTAL | $ 4,884,600 |

## 1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Tertiary treatment facility (7.36 mgd) | $ 859,650 |

## 2000 Capital Costs

| Description | Estimated Cost |
|---|---|
| Expand facilities by 2.0 mgd (9.36 mgd) | $ 1,800,000 |
| Engineering and Contingencies | 304,200 |
| TOTAL | $ 2,104,200 |

## 2000 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Combined facilities (9.36 mgd) | $ 1,024,900 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,320 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of Alternative 5 is presented in Appendix B of this section.

This alternative was not selected for further refinement because:

(a) O & M costs are greater than for biological treatment processes;

(b) large quantities of non-renewable resources (chemicals) would be required; and

(c) large volumes of chemical sludges would present handling and disposal problems.

Alternative 6.

Alternative 6 includes modification of the existing treatment system by 1975 to a 7.36-mgd trickling filter secondary treatment plant, followed by irrigation of City-owned land using the existing infiltration method of land disposal. By 1985, expansion of the irrigation facilities would be required. The spray irrigation method of land disposal would be utilized for this expansion. Also, due to continued development, a 2.0-mgd expansion of the secondary treatment facilities would be required by the year 2000.

The estimated costs of this alternative, by phases, are presented below.

**1975 Capital Costs**

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $2,786,000 |
| Engineering and Contingencies | 465,300 |
| TOTAL | $3,251,300 |

**1975 Annual O & M Cost**

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $ 174,600 |

**1985 Capital Costs**

| Description | Estimated Cost |
|---|---|
| Spray irrigation facilities | |
| Land 328 acres @ $1000/acre | $ 328,000 |
| Spray irrigation equipment | 266,400 |
| Effluent pumps | 10,000 |
| Distribution line | 15,000 |
| Subtotal | $ 619,400 |
| Engineering and Contingencies | 50,200 |
| TOTAL | $ 669,600 |

**1985 Annual O & M Costs**

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities | $ 174,600 |
| Spray irrigation facilities | 21,900 |
| TOTAL | $ 196,500 |

**2000 Capital Costs**

| Description | Estimated Cost |
|---|---|
| 2.0 mgd expansion of secondary treatment facilities (9.36 mgd) | $1,700,000 |
| Engineering and Contingencies | 292,400 |
| TOTAL | $1,992,400 |

**2000 Annual O & M Costs**

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (9.36 mgd) | $ 211,900 |
| Spray irrigation facilities | 21,900 |
| TOTAL | $ 233,800 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

**Further economic analysis of Alternative 6 is presented in Appendix B of this section.**

**Alternative 6 was not selected for further refinement because:**

**(a) the activated sludge process is more flexible and more efficient;**

**(b) the City has expressed a desire to utilize the activated sludge process (existing City plan utilizes the activated sludge process); and**

**(c) this alternative was not one of the most cost effective alternatives.**

**Alternative 7.**

**Alternative 7 includes modification of the existing treatment system by 1975 to a 7.36 mgd physical-chemical secondary treatment plant, followed by irrigation of City-owned land using the existing infiltration method of land disposal. By 1985, expansion of the irrigation facilities would be required. The spray irrigation method of land disposal would be utilized for this expansion. Also, due to continued development, a 2.0-mgd expansion of the secondary treatment facilities would be required by the year 2000.**

**The estimated costs of this alternative, by phases, are presented below:**

### 1975 Capital Costs

| Description | Estimated Cost |
|---|---|
| Physical-chemical secondary treatment facilities (7.36 mgd) | $1,350,000 |
| Engineering and Contingencies | 233,550 |
| TOTAL | $1,583,550 |

### 1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $ 349,200 |

### 1985 Capital Costs

| Description | Estimated Cost |
|---|---|
| Spray irrigation facilities | |
| Land 328 acres @ $1000/acre | $ 328,000 |
| Spray irrigation equipment | 266,400 |
| Effluent pumps | 10,000 |
| Distribution line | 15,000 |
| Subtotal | 619,400 |
| Engineering and Contingencies | 50,200 |
| TOTAL | $ 669,600 |

1985 Annual O & M Costs

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7. 36 mgd) | $349,200 |
| Spray irrigation facilities | 21,900 |
| TOTAL | $371,100 |

2000 Capital Cost

| Description | Estimated Cost |
|---|---|
| 2.0 mgd expansion of secondary treatment facilities (9. 36 mgd) | $580,000 |
| Engineering and Contingencies | 106,100 |
| TOTAL | $686,100 |

2000 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (9. 36 mgd) | $426,900 |
| Spray irrigation facilities | 21,900 |
| TOTAL | $448,800 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of alternative 7 is presented in Appendix B of this section.

Alternative 7 was not selected further refinement because:

(a) the activated sludge process is more flexible and more efficient;

(b) the City has expressed a desire to utilize the activated sludge process;

(c) this alternative was not one of the most cost effective alternatives;

(d) O & M costs are greater than for biological treatment processes;

(e) large quantities of non-renewable resources (chemicals) would be required; and

(f) large volumes of chemical sludges would present handling and disposal problems.

Alternative 8.

Alternative 8 includes modification of the existing treatment system by 1975 to a 7.36-mgd trickling filter secondary treatment plant, followed by irrigation of City-owned land using the existing infiltration method of land disposal. By 1985, expansion of the irrigation facilities would be required. The overland runoff method of land

disposal would be utilized for this expansion. Also, due to continued development, a 2.0-mgd expansion of the secondary treatment facilities will be required by the year 2000.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $2,786,000 |
| Engineering and Contingencies | 465,300 |
| TOTAL | $3,251,300 |

1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $ 174,600 |

1985 Capital Costs

| Description | Estimated Cost |
|---|---|
| Expand irrigation facilities | |
| Land 395 acres @ $1000/acre | $ 395,000 |
| Irrigation equipment | 330,000 |
| Effluent pumps | 10,000 |
| Distribution line | 15,000 |
| Subtotal | $ 750,000 |
| Engineering and Contingencies | 59,250 |
| TOTAL | $ 809,250 |

1985 Annual O & M Costs

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $ 174,600 |
| Overland runoff irrigation facilities | 26,650 |
| TOTAL | $ 201,250 |

2000 Capital Costs

| Description | Estimated Cost |
|---|---|
| 2.0 mgd expansion of secondary treatment facilities (9.36 mgd) | $1,700,000 |
| Engineering and Contingencies | 292,400 |
| TOTAL | $1,992,400 |

2000 Annual O & M Costs

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (9.36 mgd) | $ 211,900 |
| Overland runoff irrigation facilities | 26,650 |
| TOTAL | $ 238,550 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3,232,430 | $64,650 |
| 1980 | 3,890,000 | 77,800 |
| 1990 | 1,564,520 | 31,290 |
| 2020 | 4,690,920 | 93,820 |

Further economic analysis of alternative 8 is presented in Appendix B of this section.

Alternative 8 was not selected for further refinement because:

(a) the activated sludge process is more flexible and more efficient;

(b) the City has expressed a desire to utilize the activated sludge process and;

(c) this alternative was not one of the more cost effective alternatives.

Alternative 9.

Alternative 9 includes modification of the existing treatment system by 1975 to a 7.36-mgd physical-chemical secondary treatment plant, followed by irrigation of City-owned land using the existing infiltration method of land disposal. By 1985, expansion of the irrigation facilities would be required. The overland runoff method of land disposal would be utilized for this expansion. Also, due to continued development, a 2.0 mgd expansion of the secondary treatment facilities would be required by the year 2000.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

| Description | Estimated Cost |
|---|---|
| Physical-chemical secondary treatment facilities (7.36 mgd) | $1,350,000 |
| Engineering and Contingencies | 233,550 |
| TOTAL | $1,583,550 |

1975 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7.36 mgd) | $ 349,200 |

1985 Capital Costs

| Description | Estimated Cost |
|---|---|
| Expand irrigation facilities | |
| Land 395 acres @ $1000/acre | $ 395,000 |
| Irrigation equipment | 330,000 |
| Effluent pumps | 10,000 |
| Distribution line | 15,000 |
| Subtotal | 750,000 |
| Engineering and Contingencies | 59,250 |
| TOTAL | $ 809,250 |

### 1985 Annual O & M Costs

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (7. 36 mgd) | $349, 200 |
| Overland runoff irrigation facilities | 26, 650 |
| TOTAL | $375, 850 |

### 2000 Capital Costs

| Description | Estimated Cost |
|---|---|
| 2. 0 mgd expansion of secondary treatment facilities (9. 36 mgd) | $580, 000 |
| Engineering and Contingencies | 106, 100 |
| TOTAL | $686, 100 |

### 2000 Annual O & M Cost

| Description | Estimated Cost |
|---|---|
| Secondary treatment facilities (9. 36 mgd) | $426, 900 |
| Overland runoff irrigation facilities | 26, 650 |
| TOTAL | $453, 550 |

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O & M |
|---|---|---|
| 1975 | $3, 232, 430 | $64, 650 |
| 1980 | 3, 890, 000 | 77, 800 |
| 1990 | 1, 564, 520 | 31, 290 |
| 2020 | 4, 690, 920 | 93, 820 |

Further economic analysis of alternative 10 is presented in Appendix B of this section.

Alternative 9 was not selected for further refinement because:

(a) the activated sludge process is more flexible and more efficient;

(b) the City has expressed a desire to utilize the activated sludge process

(c) this alternative was not one of the most cost effective alternatives;

(d) O & M costs are greater than for biological treatment processes;

(e) large quantities of non-renewable resources (chemicals) would be required; and

(f) large volumes of chemical sludges would present handling and disposal problems.

<u>The Decentralization Alternative.</u>

An analysis was made prior to the development of alternative treatment systems to determine the feasibility of decentralization as an alternative to the expansion of the lengthy collection system to the present facility located on Red Arroyo adjacent to Ben Ficklin Road. There was found to be substantial savings in line cost, but the additional cost of treatment more than offset the savings in line cost. Land disposal would not be possible at the site; therefore, tertiary treatment would be necessary as well as a line to carry the effluent below the Bell St. Reservoir to avoid the build up of chlorides in the Reservoir which is used as an intake for the water treatment plant during periods when the Reservoir levels are low. Therefore, this alternative was dropped from further consideration.

<u>Conclusions.</u>

Alternative 1 was selected as the best plan for San Angelo because:

(a) It retains effective system that has proven to be profitable to the City and acceptable to the regulatory agencies.

(b) It meets treatment requirements of PL 92-500.

(c) It is one of the most cost-effective alternatives.

(d) During public workshop, this plan was selected by participating local interests.

(e) It returns wastes to the soil, thereby complying with the National goal of no discharge of critical pollutants by 1985.

Recommendation.

It is recommended that all steps necessary to implement the Alternative I plan be undertaken.

Continuing Responsibility.

The planning and construction of wastewater treatment facilities is only one small part of the overall treatment scheme. The application of good operation, maintenance, and control techniques are essential for proper wastewater management. The most advanced equipment available is useless if it is improperly operated or poorly maintained. As an example of the optimum care required, a modern secondary treatment facility in the 7 to 9-mgd range would employ as many as one superintendent, one chemist, six operators, one maintenance man, and two laborers to provide around-the-clock attendance. Land-disposal facilities for San Angelo would require another four to six employees, and conventional tertiary treatment could require even more.

Every operative function in a treatment plant which involves a variable treatment mode is based on a daily sampling testing and recording program. Typical tests and frequencies include:

(1) Sludge measurements in settling tanks on each shift daily.

(2) Settleable solids volume and pH measurements daily for influent and effluent.

(3) Effluent stability tests on 24-hour composite samples.

(4) Chlorine residual of effluent on each shift daily.

(5) Total and volatile solids, volatile acids, and pH of digested sludge as needed.

(6) BOD, TSS, and pH of influent and effluent daily on 24-hour composite sample.

(7) Dissolved oxygen measurement on influent, effluent, and receiving stream above and below the discharge point five days per week.

(8) For activated sludge plants, DO of mixed liquor and sludge volume index on each shift daily.

In addition to providing a record of treatment efficiency, regular sampling and testing programs aid in early detection and correction of operational malfunctions in a treatment plant.

When land disposal of effluent is utilized, an additional sampling program is usually required to monitor ground water quality in the area around the disposal site. This usually consists of a series of wells surrounding the site, from which periodic samples are drawn. Such monitoring is just one more means of maintaining the careful surveillance necessary to sound wastewater management.

In metropolitan areas like San Angelo, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater handling has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to the argument for responsible wastewater management--not just to meet government requirements, but also to protect the local environment. Whether it be the week-end fisherman appalled by poor surface water quality or the municipality concerned about increasing pollutant concentrations in their ground water resource, sound wastewater management is the concern and responsibility of everyone.

APPENDIX A

MUNICIPAL TREATMENT FACILITIES

CITY OF SAN ANGELO, TEXAS

Introduction.

During the course of study for the Colorado Wastewater Management Plan, all wastewater treatment facilities in the metropolitan areas were visited by a wastewater treatment operations specialist. The findings of the visitation report have been extracted and are summarized in the following paragraphs.

General.

The City of San Angelo presently owns and operates one sewage treatment plant, which is located on Texas Highway 380 approximately 12 miles from town. The facility which, for all practical purposes, provides only primary treatment will be replaced by a larger activated sludge facility which is currently in the design stage. The plant location is shown in Plate CV-B-2.

Description of Existing Wastewater Treatment Facility.

Wastewater reaches the current facility via a 36-inch sewer, 18 feet below grade. The flow passes through a mechanical bar screen and is collected in a wet well under the main pump station. From here the sewage is pumped to the primary clarifier, which is aerated in the center section. The overflow is pumped to a series of four holding ponds which cover approximately 65 acres. Pond water is used to irrigate the 640 acres of the adjacent City Farm.

Clarifier underflow is conveyed to the sludge thickener. Thickener overflow is returned by gravity to the main pump station wet well, while thickened sludge is pumped to the primary and then to the secondary anaerobic digester. Digested sludge is disposed of elsewhere, while collected grit and debris is dumped in an area adjacent to the plant. A 36-inch bypass line existed, which could be used to bypass the plant and convey waste flow directly to the Concho River. However, the City

reports this line has been plugged. Bypass sewage now reportedly flows into a 5.0 million gallon lagoon located near the plant. Sewage can then be pumped from the lagoon back into the plant influent line when the conditions that caused the bypass have been corrected. A schematic layout of the existing facility is shown in Figure A-1.

A new facility, now in the design stage, will replace the current installation, although most of the existing basic units will be retained and modified. The design capacity of the new plant is 7.36 mgd average dry-weather flow, with 10 mgd maximum dry-weather flow. Maximum wet-weather flow is 18.4 mgd.

| | |
|---|---|
| Design Population: | Present 62,900 |
| | Future (1990) 94,000 |
| Design Loading: | BOD - 21,500 lbs./day |
| | Suspended Solids - 12,300 lbs./day |
| Type: | Conventional activated sludge system designed to produce an effluent within permit criteria (20 mg/l BOD, 20 mg/l suspended solids, 1 mg/l chlorine residual). |
| Receiving Water: | All plant effluent will be used for irrigation of the City Farm. |

A schematic layout of the new facility is shown in Figure A-2.

Capital Improvements.

The only major expenditure will be for the construction of the new treatment facility, which is expected to cost approximately $2.8 million. Other planned expenditures on the collection system presently planned by the City are listed as follows:

| Year | Amount | Item |
|---|---|---|
| 1971-1972 | $ 75,000 | Collection mains |
| 1972 | 270,000 | 24 - 27-inch trunk outfall lines |

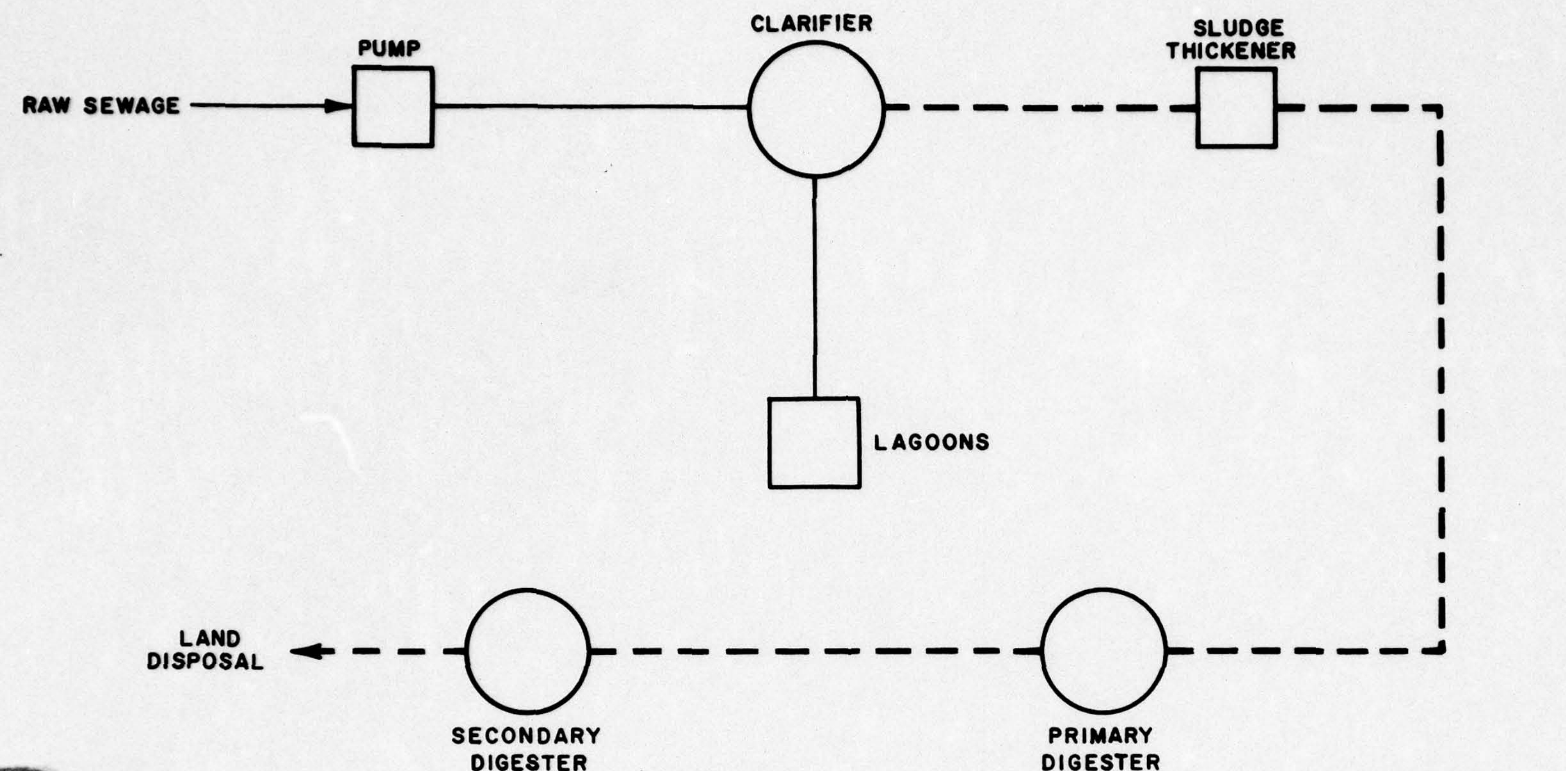
| Year | Amount | Item |
|---|---|---|
| 1973-1974 | 185,000 | 24-inch outfall lines |
| 1975 | 350,000 | 15 - 18 - 27-inch outfall lines |
| 1976-1977 | 100,000 | 18 - 24-inch outfall lines |
| 1980-1990 | 1,700,000 | 18 - 24 - 36-inch outfall lines |

Conclusions.

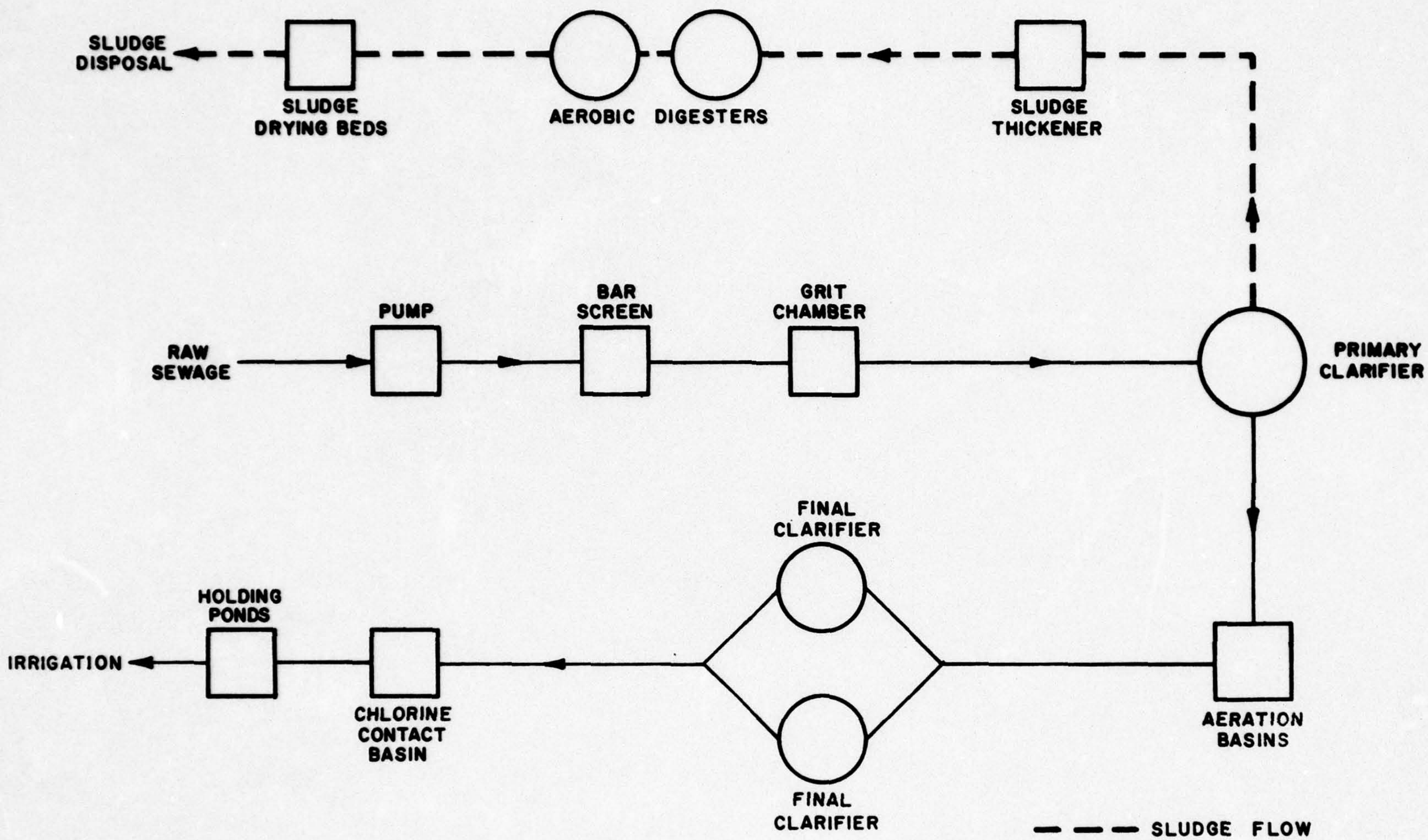
The new plant, when constructed and properly operated, should provide sufficient quality of treatment to meet existing effluent criteria, even though no discharge to a receiving water is planned. The City is negotiating with the neighboring *Irrigation District* to use plant effluent for irrigation and obtain credit for water currently withdrawn by the City from the Twin Buttes Reservoir. City Farm land will continue to be irrigated with plant effluent.

Regionalization is not considered feasible, since San Angelo is the only large town in Tom Green County.

The City prohibits by ordinance the discharge of stormwater and other runoff into the sanitary sewer system.




FLOW DIAGRAM
SAN ANGELO SEWAGE TREATMENT PLANT
FIGURE A-1




FLOW DIAGRAM
PROPOSED SAN ANGELO SEWAGE TREATMENT PLANT
FIGURE A-2

## APPENDIX B

### Economic Analysis of Alternatives

Each of the wastewater treatment facility alternatives for San Angelo was subjected to an economic analysis. The results of these analyses, by alternative, are presented as computer printouts following the cost summary. The first four column entries are input data and include a description of the item under consideration, the date by which an item is to be constructed or operational, the capital cost of each item and the annual operation and maintenance cost of each item. The next three column entries are calculated values of Capital Cost Present Worth, O&M Present Worth, and Total Present Worth, all of which were calculated at 5.5 percent interest. These values were also calculated for 7.0 percent and 10.0 percent interest, with results appearing under line entries INT RT = 0.07 and INT RT = 0.10 respectively. All values shown are in January 1972 dollars.

San Angelo, Texas

Cost Summary

| Alternative | Total Present Worth* | | |
|---|---|---|---|
| | 5.5% | 7% | 10% |
| 1 | $13,715,610 | $11,637,566 | $ 8,944,390 |
| 2 | 27,248,366 | 22,988,182 | 17,527,679 |
| 3 | 13,821,681 | 11,721,036 | 8,998,112 |
| 4 | 29,654,133 | 25,466,150 | 20,032,309 |
| 5 | 25,326,614 | 21,098,959 | 15,743,508 |
| 6 | 14,417,071 | 12,332,185 | 9,611,935 |

| Alternative | Total Present Worth* | | |
|---|---|---|---|
| | 5.5% | 7% | 10% |
| 7 | $15,273,405 | $12,777,847 | $9,585,999 |
| 8 | 14,522,875 | 12,415,497 | 9,665,597 |
| 9 | 15,379,467 | 12,861,312 | 9,639,717 |

*Total Present Worth = Capital Cost Present Worth plus O&M Present Worth.

San Angelo Alternatives

Cost Comparison

ALTERNATIVE 1

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS SECONDARY | 1975 | 2150000. | 204000. | 1830969. | 2874823. | 4705792. |
| EXPAND IRRIG | 1985 | 669600. | 21900. | 333836. | 168041. | 501878. |
| EXP SECONDARY | 2000 | 1058400. | 48800. | 236364. | 130237. | 366600. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 17255870. | 17882450. | 8644519. | 5071090. | 13715610. |
| INT RT=.070000 | | 17255870. | 17882450. | 7739934. | 3897632. | 11637566. |
| INT RT=.100000 | | 17255870. | 17882450. | 6455709. | 2488681. | 8944390. |

ALTERNATIVE 2

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS TERTIARY | 1975 | 7306750. | 859650. | 6222528. | 12114419. | 18336947. |
| EXP TERTIARY | 2000 | 1881600. | 131100. | 420202. | 349877. | 770079. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 22566220. | 48266200. | 12886080. | 14362286. | 27248366. |
| INT RT=.070000 | | 22566220. | 48266200. | 11795328. | 11192854. | 22988182. |
| INT RT=.100000 | | 22566220. | 48266200. | 10193176. | 7334503. | 17527679. |

ALTERNATIVE 3

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS SECONDARY | 1975 | 2150000. | 204000. | 1830969. | 2874823. | 4705792. |
| OR-IRRIG | 1985 | 809250. | 26650. | 403460. | 204489. | 607949. |
| EXP SECONDARY | 2000 | 1058400. | 48800. | 236364. | 130237. | 366600. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |

## San Angelo Alternatives

### Cost Comparison
### (Cont'd)

**ALTERNATIVE 3**

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 17395520. | 18048700. | 8714143. | 5107538. | 13821681. |
| INT RT=.070000 | | 17395520. | 18048700. | 7797883. | 3923153. | 11721036. |
| INT RT=.100000 | | 17395520. | 18048700. | 6496161. | 2501951. | 8998112. |

**ALTERNATIVE 4**

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| TF TERTIARY | 1975 | 11933000. | 698500. | 10162306. | 9843450. | 20005756. |
| EXP TERTIARY | 2000 | 4888800. | 155600. | 1091776. | 415262. | 1507038. |
| CULLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| CULLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| CULLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| CULLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 30199670. | 41504450. | 17497431. | 12156702. | 29654133. |
| INT RT=.070000 | | 30199670. | 41504450. | 16024016. | 9442134. | 25466150. |
| INT RT=.100000 | | 30199670. | 41504450. | 13877476. | 6154834. | 20032309. |

**ALTERNATIVE 5**

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TCTAL PRES WORTH |
|---|---|---|---|---|---|---|
| PC TERTIARY | 1975 | 4884600. | 859650. | 4159792. | 12114419. | 16274211. |
| EXP TERTIARY | 2000 | 2104200. | 165300. | 469914. | 441149. | 911063. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 20366670. | 48950200. | 10873056. | 14453558. | 25326614. |
| INT RT=.070000 | | 20366670. | 48950200. | 9851612. | 11247347. | 21098959. |
| INT RT=.100000 | | 20366670. | 48950200. | 8388815. | 7354693. | 15743508. |

## San Angelo Alternatives

### Cost Comparison
(Cont'd)

**ALTERNATIVE 6**

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| TF SECONDARY | 1975 | 3251300. | 174600. | 2768852. | 2460510. | 5229362. |
| SPRAY IRRIG | 1985 | 669600. | 21900. | 333836. | 168041. | 501878. |
| EXP SECONDARY | 2000 | 1992400. | 37300. | 444946. | 99546. | 544492. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 19291170. | 16329450. | 9790984. | 4626087. | 14417071. |
| INT RT=.070000 | | 19291170. | 16329450. | 8779398. | 3552787. | 12332185. |
| INT RT=.100000 | | 19291170. | 16329450. | 7347899. | 2264036. | 9611935. |

**ALTERNATIVE 7**

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| PC SECONDARY | 1975 | 1583550. | 349200. | 1348573. | 4921020. | 6269593. |
| SPRAY IRRIG | 1985 | 669600. | 21900. | 333836. | 168041. | 501878. |
| EXP SECONDARY | 2000 | 686140. | 77700. | 153230. | 207364. | 360594. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 16317160. | 24994450. | 8078989. | 7194416. | 15273405. |
| INT RT=.070000 | | 16317160. | 24994450. | 7221553. | 5556294. | 12777847. |
| INT RT=.100000 | | 16317160. | 24994450. | 6004313. | 3581685. | 9585999. |

**ALTERNATIVE 8**

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| TF SECONDARY | 1975 | 3251300. | 174600. | 2768852. | 2460510. | 5229362. |
| OR IRRIG | 1985 | 809250. | 26650. | 403460. | 204489. | 607949. |
| EXP SECONDARY | 2000 | 1992400. | 37200. | 444946. | 99279. | 544225. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |

## San Angelo Alternatives

## Cost Comparison
(Cont'd)

### ALTERNATIVE 8

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 19430820. | 16493700. | 9860608. | 4662267. | 14522875. |
| INT RT=.070000 | | 19430820. | 16493700. | 8837348. | 3578149. | 12415497. |
| INT RT=.100000 | | 19430820. | 16493700. | 7388351. | 2277246. | 9665597. |

### ALTERNATIVE 9

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| PC SECONDARY | 1975 | 1583550. | 349200. | 1348573. | 4921020. | 6269593. |
| OR IRRIG | 1985 | 809250. | 26650. | 403460. | 204489. | 607949. |
| EXP SECONDARY | 2000 | 686100. | 77700. | 153221. | 207364. | 360585. |
| COLLECTION SYS | 1975 | 3232430. | 64650. | 2752782. | 911065. | 3663847. |
| COLLECTION SYS | 1980 | 3890000. | 77800. | 2534720. | 813449. | 3348168. |
| COLLECTION SYS | 1990 | 1564520. | 31290. | 596811. | 173476. | 770287. |
| COLLECTION SYS | 2020 | 4690920. | 93820. | 359038. | 0. | 359038. |
| INT RT=.055000 | | 16456770. | 25160700. | 8148604. | 7230863. | 15379467. |
| INT RT=.070000 | | 16456770. | 25160700. | 7279497. | 5581815. | 12861312. |
| INT RT=.100000 | | 16456770. | 25160700. | 6044762. | 3594955. | 9639717. |

# APPENDIX C

## EVALUATION ANALYSIS

**This appendix presents an evaluation of the three most viable alternatives with respect to environmental, social, economic, technological, and resource conservation considerations. The status of the existing wastewater treatment facility has used as the base condition from which the evaluations were made.**

## SAN ANGELO, TEXAS
### Evaluation Analysis

| | ALTERNATIVE 1: Waste load allocation Plan—Secondary Treatment by Activated Sludge Process followed by Infiltration Method of Land Disposal. Expansions will utilize Spray Irrigation. | ALTERNATIVE 2: Biological Tertiary Treatment—by the Activated Sludge Process; includes nitrification, denitrification, filtration, activated carbon treatment, chlorination, and aeration of the effluent. | ALTERNATIVE 3: Secondary biological treatment accomplished by the activated sludge process and tertiary treatment by the overland runoff method of land disposal. |
|---|---|---|---|
| A. Environmental Quality | | | |
| 1. Water Resource | | | |
| a. Effluent Quality | Removal of BOD and SS would approach 100% and would be higher than attainable by overland runoff. High removal of nutrients. Best removal of phosphorus. | Removal of BOD/SS would approach 98%. Better removal of phosphorus than overland runoff. | Removal of BOD/SS would approach 98%. Less removal of phosphorus than other alternatives. |
| b. Groundwater | Positive potential for recharge. No detrimental effect due to high quality water. | Positive potential for recharge. For this alternative, probably will not be used for recharge, rather, for industrial reuse. | Positive potential for recharge. No detrimental effect due to high quality water. |
| c. Streamflow | No change from existing. No flow to streams other than small flow from percolation. | Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry. | No change from existing. No flow to streams other than small flow from percolation. Small flow from overland runoff. |
| 2. Air Resource | | | |
| a. Odors | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. |
| b. Other sources | Aerosol potential slight. | Carbon regeneration could cause problems. | Aerosol potential slight. |
| 3. Land Resource | | | |
| a. Land Quality | Increase productivity. | Land released for other uses. | Increase productivity. |
| b. Land Utilization | Large area requirement. Committed for long period of time (328 acres). | Small land requirements (about 5 acres). | Largest land requirement. Committed long period of time (395 acres). |

## SAN ANGELO, TEXAS

### Evaluation Analysis (Cont'd.)

| | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 |
|---|---|---|---|
| A. Environmental Quality (Cont'd.) | | | |
| 4. Biological | | | |
| a. Zoological | Would change wildlife habitat characteristics. Probably increase species diversity and total number. | Change depends upon use of land no longer needed for disposal. | Would change wildlife habitat characteristics. Probably increase species diversity and total number. |
| b. Botanical | Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing. | Change depends upon use of land no longer needed for disposal. | Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing. |
| 5. Geological | If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge. | Change depends upon use of land no longer needed for disposal. | If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge. |
| B. Social | | | |
| 1. Manpower | Additional personnel required. Non-technical for land disposal system available locally. | Additional personnel required. Highly skilled technical personnel may not be available locally. | Additional personnel required. Non-technical for land disposal system available locally. |
| 2. Aesthetics | Land disposal site could be used to influence direction of growth—utilized as green belt. | No problems due to remoteness of plant from populated areas. | Land disposal site could be used to influence direction of growth—utilized as green belt. |
| 3. Political acceptability | System presently utilized and accepted. Possible objections to increase of city owned land if leasing is not available. | May not be acceptable because of change in water use patterns. | System presently utilized and accepted. Possible objections to increase of city owned land if leasing is not available. |
| C. Economic | Increased agricultural revenue. Additional employment required. (Regional effect.) | Larger revenue potential because of higher economic use of water. Increase in skilled employment. (Local effect.) | Increased agricultural revenue. Additional employment required. (Regional effect.) |
| D. Technology | | | |
| 1. Reliability—Flexibility | More reliable. Effluent quality not as susceptible to load variations or influent quality. | More flexible. Effluent available directly for many uses. | More reliable. Effluent quality not as susceptible to load variations or influent quality. |

## SAN ANGELO, TEXAS

### Evaluation Analysis (Cont'd.)

| | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 |
|---|---|---|---|
| D. Technology (Cont'd.) | | | |
| 2. Construction Effects | Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible. | Less detrimental because of smaller land requirements. | Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible. |
| E. Institutional Arrangements | No change if city operates additional land disposal systems. Difficulties *could be encountered if contract with* farmer(s) for operation of irrigation systems. | Change could be required to restructure functions and responsibilities of public *works departments.* | No change if city operates additional land disposal systems. Difficulties *could be encountered if contract with* farmer(s) for operation of irrigation systems. |
| F. Resource Conservation | Large land areas would be committed *for many years.* | Chemical requirements would commit *large quantities of non-renewable* resources. | Large land areas would be committed *for many years.* |

## AREAWIDE PLAN
## FOR
## BRONTE, TEXAS

The City of Bronte is an incorporated, general law municipality located in the eastern portion of Coke County on the intersection of U.S. Highway 277 and State Highway 158, approximately 35 miles north of San Angelo, Texas. The incorporated area of the City encompasses approximately 265 acres and is within the jurisdiction of the Concho Valley Council of Governments.

The City has little topographical relief and is drained by West Kickapoo and Kickapoo Creek. The City drains to the south-southeast into the two creeks which run west-northwest to south and north to south. The town's elevation fluctuates by about 15 feet from the northwest to the southeast. The City is underlain by soils of the Winters-Olston-Latom type. The Winters-Olston-Latom soils are generally 6-14 inches thick and characterized by a sandy to clay loam surface overlying a blocky firm clay loam to light clay. In some areas the underlying layer is a calcareous sandstone on a sandy conglomerate ranging from weakly cemented to indurated. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks and sewage lagoons have moderate to severe limitations.

Population data developed by the TWQB for use in this study indicate a moderate decrease in population is expected for Bronte over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 925 | 800 | 710 | 430 |

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commerical and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with considerable contribution from local oilfield activity but no known industrial contribution.

The City is accessible by U.S. Highway 277 and State Highway 158 and is served by the Panhandle and Santa Fe Railroad. No population growth

is anticipated due to a lack of a developable resource base and outward migration to nearby metropolitan areas.

The municipal water supply is obtained from a surface water source, Oak Creek Lake, eleven miles to the north of town. Storage for the system is provided by one 0.5-mg ground storage tank and one 0.75-mg elevated tank. The projected water use is a reflection of the population trend and has been projected by the Texas Water Development Board to be as follows:

**Water Use Projections***

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.13 | 0.12 | 0.11 | 0.07 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

**Waste Load Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd: | 0.08 | 0.07 | 0.06 | 0.04 |
| BOD in lb./day: | 160 | 140 | 130 | 80 |
| TSS in lb./day: | 180 | 170 | 160 | 100 |

The existing wastewater collection system is shown on Plate CV-1. It appears the system is adequate for present needs, serves the entire population desiring service and, with only minor extensions and connections shown, will meet the future needs of the projected declining population. The estimated total project cost for these extensions, including engineering and contingencies, is $44,600. There are no significant areas of town where septic tanks are still the primary means of sewage disposal.

The existing sewage treatment plant for the City of Bronte is located southeast of the city limits near S.H. 158 as shown on Plate CV-1.

The plant was built in 1960 with a design capacity of 0.150 mgd and presently serves approximately 700 people. It apparently has been maintained in fair physical conditions. The plant is of the Imhoff oxidation pond type and consists of a bar screen, Parshall fume, an Imhoff tank, two oxidation ponds, sludge drying beds, and a holding pond on adjacent property which receives effluent for irrigation. Available sampling data for the secondary facilities published by the Texas State Department of Health and Texas Quality Board are presented below:

Influent-Effluent Data (mg/l)

| | TSDH (1971) | TWQB (1969) |
|---|---|---|
| Raw BOD | 170 | 140 |
| Raw TSS | 100 | 95 |
| Final BOD | 20 | 20 |
| Final TSS | 124 | 88 |

Sludge disposal consists of using the solids for landfill, and effluent from the oxidation pond is used for irrigation. The plant is operating under its stated design capacity.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and "the best practicable waste treatment technology" by 1983. Under the present interpretation of this law, land disposal of effluent through irrigation meets all requirements so long as the disposal is carried out in an approved manner and so long as no effluent is introduced in to the surface water or ground water resource either directly, as runoff, or by direct percolation. The irrigation disposal method currently utilized by tne City meets all the requirements of the Law and is providing a high degree of final treatment for the wastewater while proving a benefit to the local economy in a semi-arid area. The method also eliminates any contamination of Kickapoo Creek or the Colorado River and, through reuse, minimizes the drain on the available water resource.

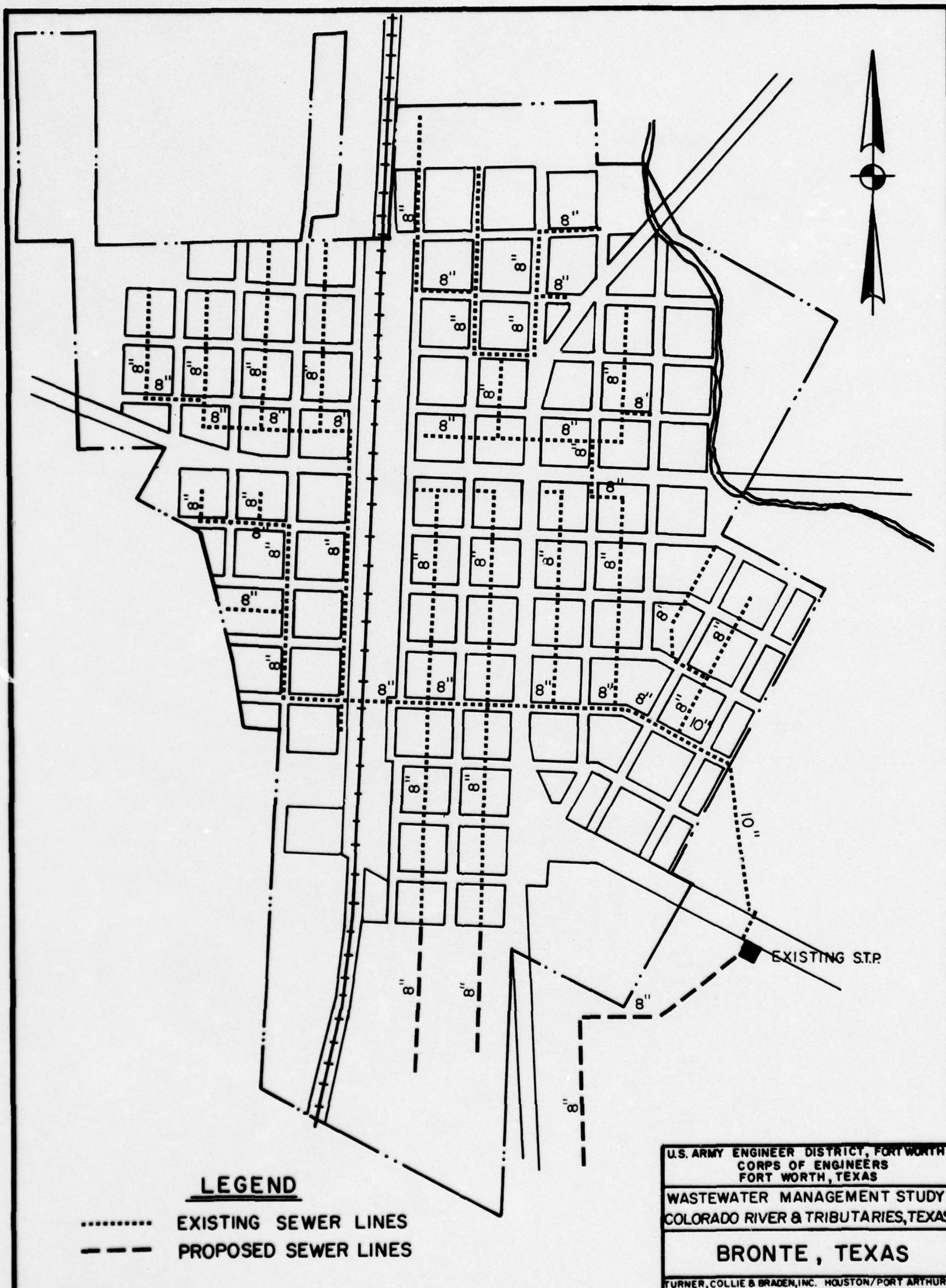
The present ponds were designed with sufficient capacity that they have never filled to a point where they would discharge to the irrigation holding pond. Therefore, no expansions or modifications are proposed to serve the projected declining population.

It is recommended that the aforementioned non-discharge treatment system be continued. However, should the City of Bronte wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $103, 700, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $91, 800, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $85, 500, including engineering and contingencies.



8"
10"
EXISTING S.T.P.
LEGEND
EXISTING SEWER LINES
PROPOSED SEWER LINES
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
BRONTE, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 800'
PLATE: CV-1

AREAWIDE PLAN
FOR
ROBERT LEE, TEXAS

The City of Robert Lee is an incorporated general law municipality located in the central portion of Coke County on the intersection of State Highways 208 and 158 approximately 35 miles north of San Angelo, Texas. The incorporated area of the City encompasses approximately 630 acres. Robert Lee is the county seat of Coke County and is within the jurisdiction of the Concho Valley Council of Government.

The City has moderate topographical relief and is drained by Mountain Creek east of town and the Colorado River to the south. Ground elevations fall approximately 80 feet from the north to the south across the City.

The City is underlain by soils of the Miles-Potter-Uvalde and Norwood-Wichita types. The Miles-Potter-Uvalde soils are generally 6-15 inches deep with a sandy loam or clay loam surface. The underlying layer is at times a caliche layer several feet thick.

Permeabilities range from 2.0 to 6.3 inches per hour. Septic tanks have only slight limitations and sewage lagoons have moderate limitations due to the moderate permeability of the soils. The other major groups of soils in this area are the Norwood-Wichita soils which are generally 9-25 inches thick with a calcareous silt loam to silt clay loam surface underlain by a very friable granular silt loam or silty clay loam several feet thick.

Population data developed by the Texas Water Development Board for use in this study indicate a moderate decrease in population is expected for Robert Lee over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,119 | 990 | 890 | 590 |

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares

in the central areas of the City. The economic resource base is primarily agricultural with no known industrial contribution. The development of nearby E. V. Spence Reservoir may have significant impact on the growth potential of Robert Lee. The reservoir could provide a base for future population growth that would offset the population decline as projected for this report.

The City is accessible by State Highways 208 and 158 and is a local trade center; however, population growth is not anticipated due to a lack of an adequate resource base or any developable natural resource.

Although the City maintains two shallow water wells to supplement the water system, the supply is obtained primarily from surface water sources. The City owns Mountain Creek Reservoir, which produces water with fairly high corrosive tendencies and has lost a significant portion of its yield to silting. To ensure a dependable year-round supply, a pipeline has been constructed to E. V. Spence Reservoir. Storage for the system is provided by a 0.25-mg ground storage tank and a 0.1-mg elevated reservoir. Waste sediments and sludges for the water treatment plant are typical of such wastes and are drained into ponds at the plant where they are allowed to evaporate. Dried sludges are conveyed to a landfill site.

The projected water use is a reflection of the population trend and has been projected by the Texas Water Development Board to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.18 | 0.17 | 0.16 | 0.13 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Influent-Effluent Data (mg/l)

| | TSDH (1971) | TWQB (1969) |
|---|---|---|
| Raw BOD | 320 | 120 |
| Raw TSS | 240 | 115 |
| Final BOD | 20 | 20 |
| Final TSS | 20 | 23 |

Sludge disposal consists of spreading the solids on a tract of land while effluent from the chlorination facility is presently discharged into the Colorado River.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. To meet the requirement for a higher level of treatment by 1983 which insures no discharge of pollutants, it is proposed that irrigation of the effluent be adopted. At the present time, according to information supplied by the Land Office, a tract of land across the Colorado River from the plant site is being irrigated by a local farmer. It is proposed that when the higher level of treatment requirement is imposed, the City contract with and deliver all effluent to the farmer for his use on a year-round basis. The cost of this method of disposal would be borne by the landowner.

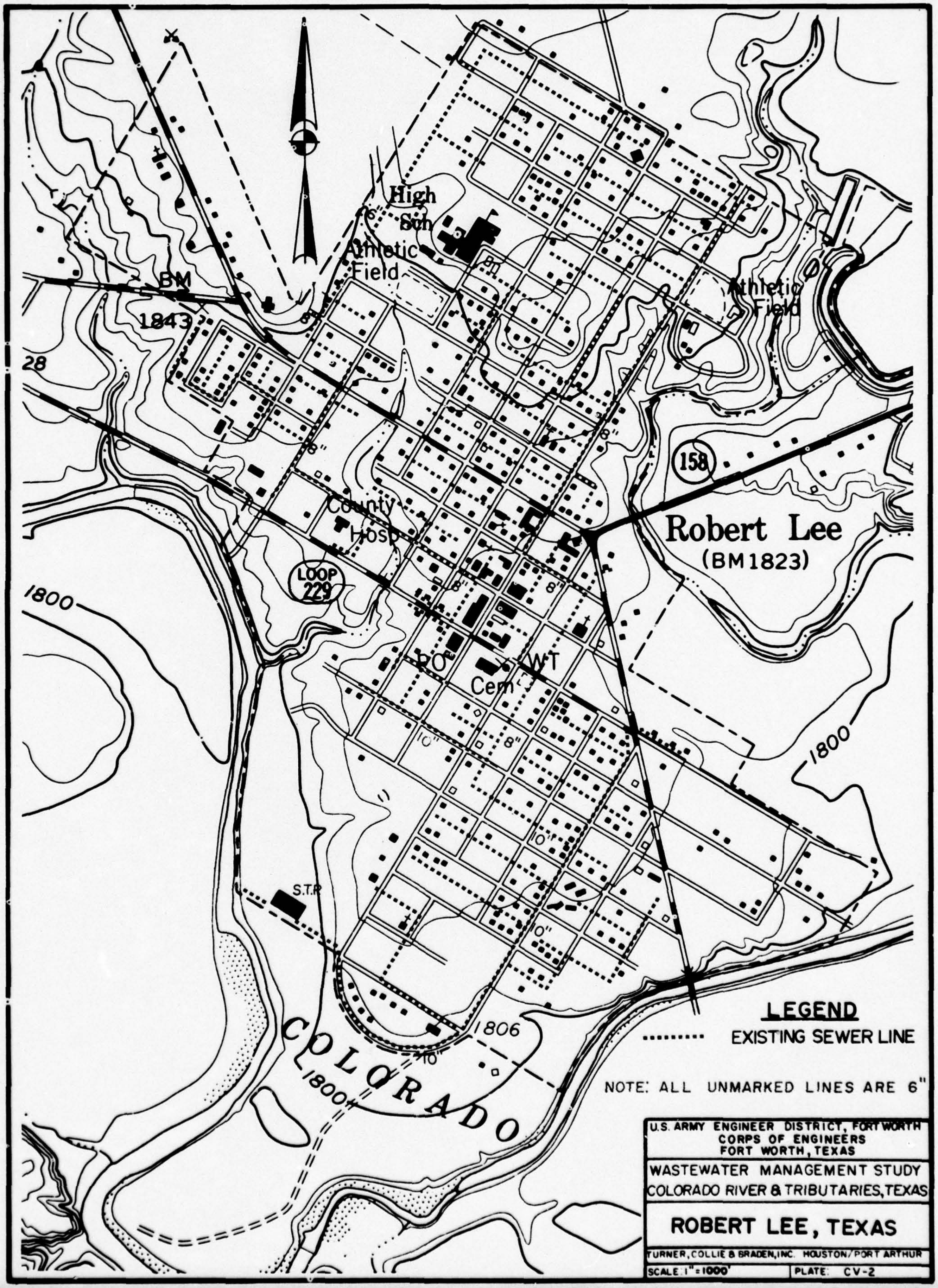
Irrigation with secondary effluent has proven to be an acceptable form of disposal in the arid regions of Texas. The method will (a) prove to be beneficial to the local economy, (b) eliminate the existing dual drain on the available water resource by utilizing reuse, and (c) eliminate any adverse impacts caused by effluent from the present secondary facility on the aquatic life of the Colorado River.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge treatment system plan be undertaken. However, should the City of Robert Lee wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities including parital filtration and phosphorus, ammonia-nitrogen

and organic nitrogen reduction facilities at an approximate capital cost of $129,500, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $107,500, including engineering and contingencies.


High Sch
Athletic Field
BM 1843
28
County Hosp
LOOP 229
158
Robert Lee
(BM1823)
Athletic Field
PO
WT
Cem
S.T.P.
1800
1806
COLORADO
8"
10"
LEGEND
EXISTING SEWER LINE
NOTE: ALL UNMARKED LINES ARE 6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
ROBERT LEE, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'
PLATE: CV-2

AREAWIDE PLAN
FOR
EDEN, TEXAS

The City of Eden is an incorporated municipality located 40 miles southeast of San Angelo at the intersection of U.S. Highways 87 and 83 in south central Concho County. The City lies within the jurisdiction of the Concho Valley Council of Governments and has an incorporated area encompassing approximately 530 acres.

Eden has moderate topographical relief and is drained by Harden Branch. The direction of drainage for the City is separated by a ridge which starts near the center of town and runs north through the City. The land drains to the southeast, east of the ridge and to the southwest, west of the ridge.

The City of Eden is underlain by soils of the Frio-Uvalde and Tarrant stony types. The Frio-Uvalde soil types are found mainly along Harden Creek, and elsewhere the soil is of the Tarrant stony type. The permeability of the Tarrant stony soils ranges from 0.2 to 0.6 inch per hour. Septic tanks and sewage lagoons have severe limitations in this area due to less than 20 inches of cover to hard limestone. The soil has generally friable, highly calcareous clay surface, 4 to 8 inches thick, over broken limestone or limestone bedrock.

Population data developed by the Texas Water Development Board used for this study indicate that a fairly rapid decrease in population is expected for Eden over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,291 | 1,060 | 850 | 500 |

The land use for Eden is typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural.

The City is accessible by U.S. Highways 87 and 83 and is served by the Atchison, Topeka, and Santa Fe Railroad. Due to the lack of industry

or available developable natural resource, there is no anticipated population growth.

The municipal water supply is obtained from a ground water source by four wells with capacities of 45, 45, 75 and 250 gpm capacities. Storage for the system is provided by one ground storage tank of 0.75 million gallons and an elevated tank of 0.05 million gallons. The projected water use is a reflection of the population trend and has been projected by the Texas Water Development Board to be as follows:

**Water Use Projections***

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.16 | 0.16 | 0.12 | 0.07 |

*Flows in mgd

Municipal wastewater return flows have also been projected for Eden by the TWQB to be as follows:

**Waste Load Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd | 0.11 | 0.09 | 0.07 | 0.04 |
| BOD in lbs./day: | 220 | 190 | 150 | 190 |
| TSS in lbs./day: | 260 | 220 | 190 | 94 |

The existing wastewater collection system is shown on Plate CV-3. It appears that the system is adequate for present needs and, with only minor extensions and expansions as needed, will fulfill the needs of the projected declining population. There are a few scattered areas of town where septic tanks are still the primary means of sewage disposal; however, no plans exist to abandon those facilities. At present, there is no industrial contribution to the system and none is expected in the future.

The existing sewage treatment plant is located south of the Atchison, Topeka, and Santa Fe Railroad and east of U.S. Highway 83. The plant was built in 1960 and presently serves about 800 people. The Imhoff

oxidation pond type plant has a design capacity of 0.19 million gallons per day and consists of an Imhoff tank, sludge beds, and oxidation ponds. The plant has been maintained in fair structural and mechanical condition. What influent and effluent data that is available is as published by the Texas State Department of Health:

Influent-Effluent Data (mg/l)
(11/16/71)

| | |
|---|---|
| Raw BOD | 190 |
| Raw TSS | 60 |
| Final BOD | 18 |
| Final TSS | 129 |

Sludge from the treatment plant is used as landfill and the effluent is held in ponds until it evaporates. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, total retention and evaporation of effluent as practiced by Eden meets all requirements when the retention is executed in an approved manner and when no effluent is introduced directly into the surface water or ground water resource either as runoff or by direct percolation without adequate treatment time. Apparently no discharge has ever occurred from the ponds, and, therefore, with a sharply declining population no need exists for any modification to the present treatment scheme. It is suggested the City encourage local farmers to draw irrigation water from the retention ponds in order to effect some reuse of this valuable water resource that would otherwise be lost to evaporation.

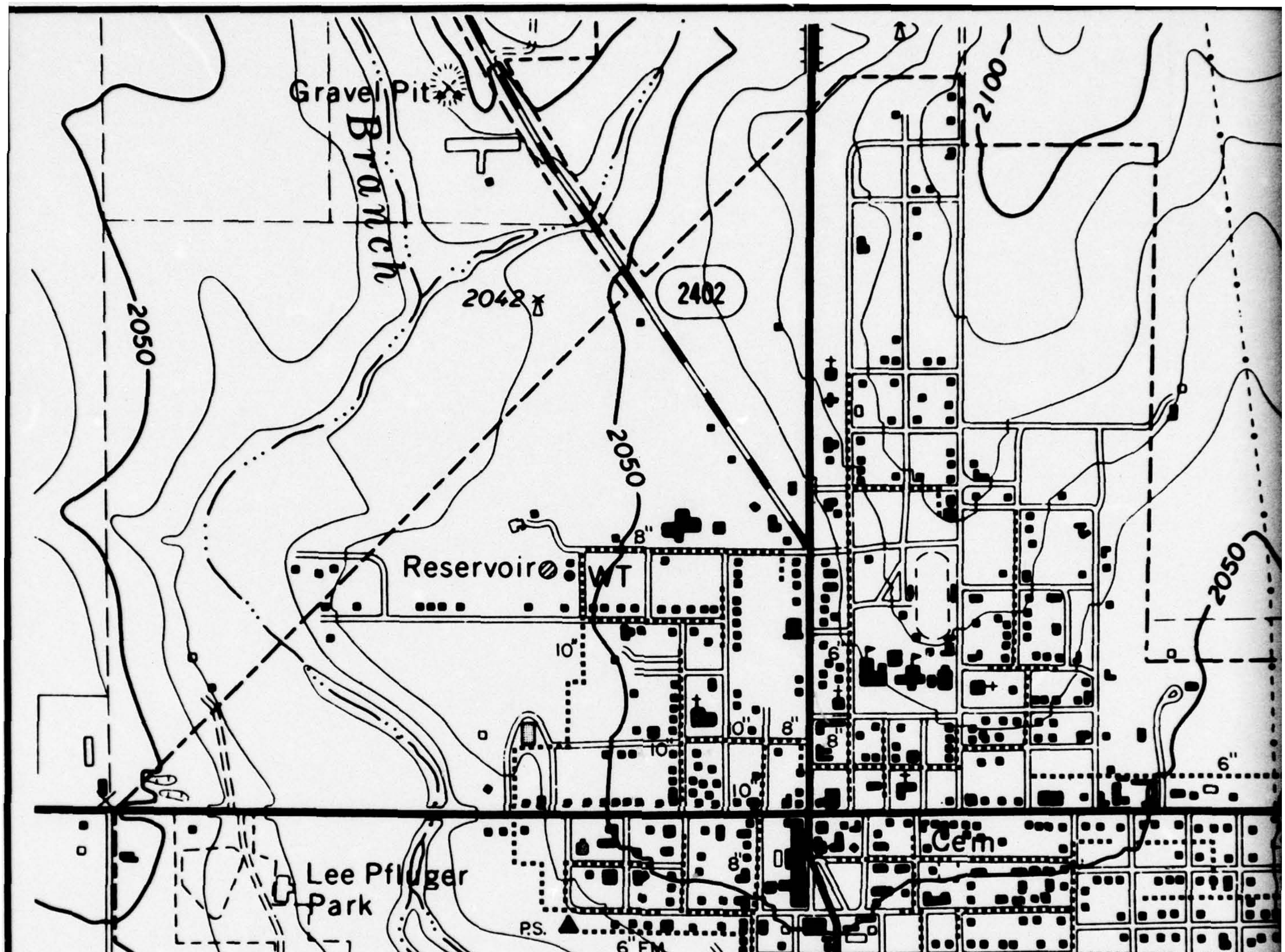
It is recommended that the aforementioned no-discharge treatment system be continued. However, should the City of Eden wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $193,120, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and

organic nitrogen reduction facilities at an approximate capital cost of $122,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $84,000, including engineering and contingencies.


Gravel Pit
Branch
2100
2402
2042
2050
2050
Reservoir
WT
8"
10"
6"
8"
10"
Lee Pfluger
Park
P.S.
6" F.M.
Cem
2050
6"
8"
10"
2020
10"
2026
2008
2050
NOTE: ALL UNLAB


NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

EDEN, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'

PLATE CV-3

## AREAWIDE PLAN
## FOR
## MERTZON, TEXAS

The City of Mertzon, an incorporated general law municipality, is located in the eastern portion of Irion County at the intersection of U.S. Highway 67 and F.M. 2469, approximately 25 miles southwest of San Angelo, Texas. The incorporated area of the City encompasses approximately 1,800 acres. Mertzon is the county seat of Irion County and is within the jurisdiction of the Concho Valley Council of Governments.

The City has moderate topographic relief and generally drains to the east into Spring Creek which borders the town on the east.

The City is underlain by the Tarrant-Ector soils on the west and Knippa-Frio soils on the east. Tarrant soils have a friable, highly calcareous, clay surface, four to eight inches thick, over broken or partly weathered limestone or limestone bedrock at less than twelve inches beneath the soil. Ector soils have a friable, strongly calcareous, gravelly or stony, loam surface, three to twelve inches thick, over limestone with a coating of caliche. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks and sewage lagoons both have severe limitations due to the shallow depth of the limestone bedrock. The Knippa soils have a crumbly, calcareous, clay surface, 15 to 34 inches thick, over crumbly, blocky, strongly calcareous, clay surface. The Frio soil has a granular, friable, silty clay loam to clay loam, 12 to 25 inches thick, over granular and subangular, blocky, friable, strongly calcareous clay loam to silty clay underlain by beds of rounded limestone and gravel. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks have severe limitations in these soil types also.

Population data, developed by the Texas Water Development Board for use in this study, indicate that a slight decrease in population is expected for Mertzon over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 513 | 490 | 470 | 400 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is primarily based on cattle and sheep ranching with some contribution from local oil field activity.

Accessible by U.S. Highway 67, the City is served by the Atchison, Topeka and Santa Fe Railroad. Population growth is not anticipated due to the lack of adequate economic activity or any significant resource which could be developed.

The municipal water supply is obtained from ground water sources. Water is supplied by a privately-owned system drawing from shallow wells. The anticipated water use, a reflection of the population trend, has been projected by the TWQB to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.04 | 0.04 | 0.04 | 0.04 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow in mgd | 0.1 | 0.09 | 0.07 | 0.04 |
| BOD in lbs./day | 87 | 88 | 88 | 76 |
| TSS in lbs./day | 100 | 100 | 110 | 92 |

The City has no existing wastewater collection system or sewage treatment plant. Septic tanks are the only means of sewage disposal in the City, and the concentration of septic tanks, coupled with the thin cover of soil over limestone bedrock, have begun to contaminate the shallow ground water supply.

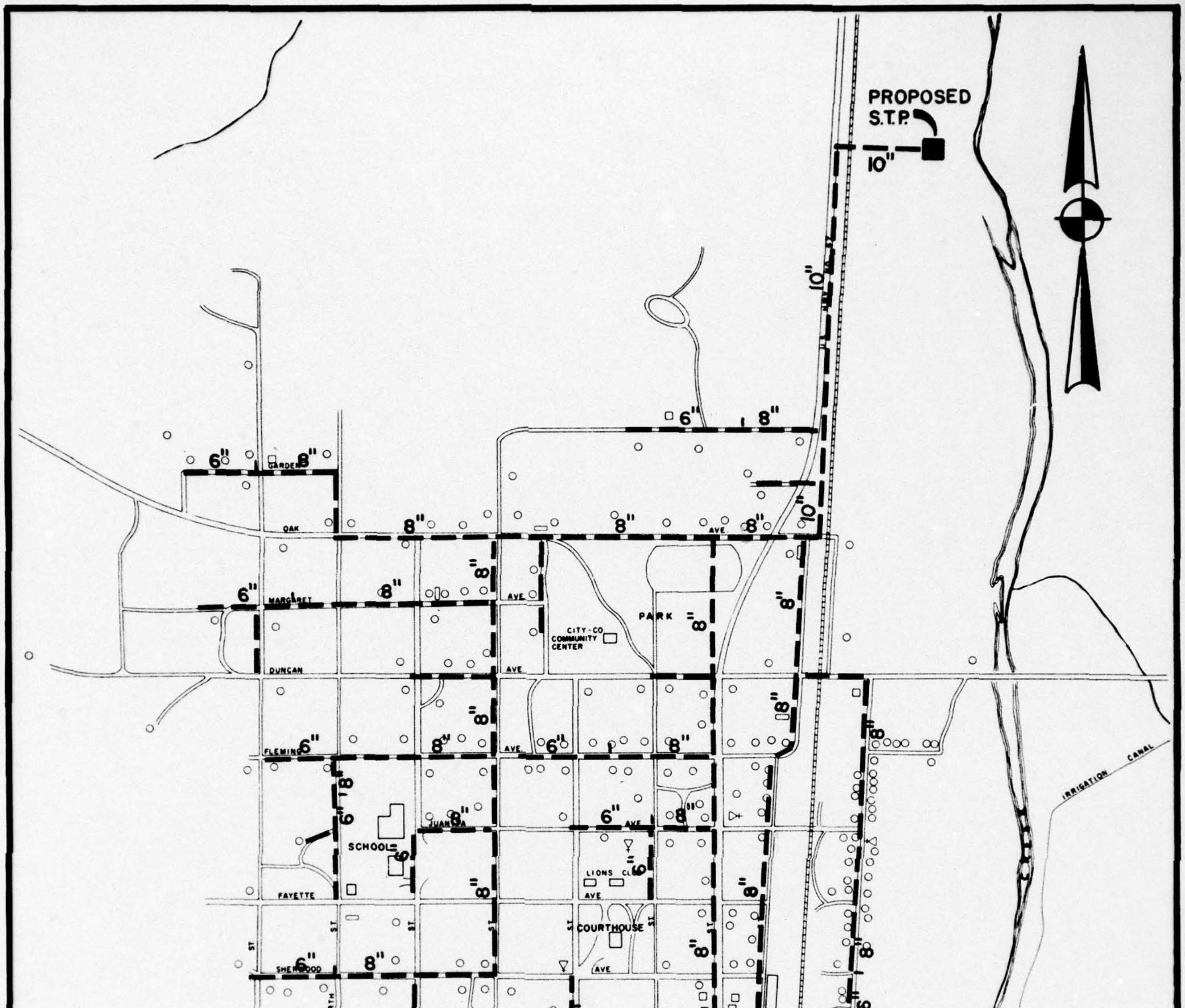
Mertzon has made application for financial assistance to construct the collection and treatment system shown on Plate CV-4. Review of the proposed collection system indicates that it is apparently efficient and will adequately serve the inhabited area of the City. The estimated cost for the collection system is $458,300. To be in compliance with PL 92-500, the City would have to provide, by 1977, a secondary level of treatment until 1983, and at that point provide the best practicable waste treatment technology. Under the present interpretation of the law, disposal of effluent by application onto the land as irrigation provides a high degree of treatment. Examination of maps depicting irrigated acreages in Irion County indicates a concentration of irrigation sites immediately north of the proposed treatment plant. It is therefore proposed that the City enter into contract with the irrigating farmers and provide all effluent to them. This method of disposal will prove to be a valuable reuse of a scarce natural resource in an arid area and will be beneficial to the local economy. The estimated capital cost for construction of a conventional secondary facility by 1977 would be $76,000, including engineering and contingencies.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Mertzon wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate cost of $76,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $77,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $61,000, including engineering and contingencies.




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MERTZON, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: CV-4

## AREAWIDE PLAN
## FOR
## JUNCTION, TEXAS

The City of Junction is an incorporated general law municipality located in the central portion of Kimble County at the intersection of U.S. Highways 290, 83 and 377, approximately 140 miles west of Austin, Texas. The incorporated area of the City encompasses approximately 780 acres. Junction is the county seat of Kimble County and is within the jurisdiction of the Concho Valley Council of Governments.

The City is situated in the Llano River valley. The topographical relief is slight, and elevations vary only about 20 feet. The northern portion of the City drains north and east to the North Fork Concho River and the southern portion drains to the south and east to the South Fork Concho River.

Junction is underlain principally by Knippa-Frio soils. These soils, generally 15 to 34 inches thick, are characterized by a strongly calcareous clay surface. Permeabilities range from 0.20 to 0.63 inch per hour and, as a result, septic tanks have only slight limitations.

The Tarrant-stony soils which underlie the City to the west are 4 to 8 inches thick with a highly calcareous clay surface underlain by partly broken limestone or limestone bedrock. Permeabilities range from 0.2 to 0.6 inch per hour with severe limitations on both septic tanks and sewage lagoons due to the shallow depth at which bedrock appears.

Population data developed by the Texas Water Development Board for use in this study indicate a fairly constant population level is anticipated over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 2,660 | 2,700 | 2,750 | 2,630 |

Significant population growth is not anticipated due to a lack of developable natural resource or industrial interest.

The City's land use, typical of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with the only known industrial contribution from a cedar oil mill. The City is easily accessible via U.S. Highways 290, 83 and 377, two bus lines and a county municipal airport.

The municipal water supply is obtained from a ground water source. Four shallow (20-50 ft.) wells serve the City and storage is provided by two ground storage reservoirs and two elevated storage reservoirs with capacities of 0.235 mg, 0.250 mg, 0.075 mg, and 0.050 mg, respectively.

The projected water use, a reflection of the population trend, has been projected by the TWQB to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.64 | 0.70 | 0.73 | 0.76 |
| Industrial Use: | 0.53 | 0.59 | 0.63 | 0.77 |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| BOD in lbs./day: | 450 | 490 | 490 | 500 |
| TSS in lbs./day: | 430 | 570 | 600 | 600 |

The existing wastewater collection system, currently serving approximately 900 connections, is illustrated on Plate CV-5. At present, there is only one significant area of town where private septic tanks are utilized for sewage disposal. The area is a degenerated housing area, occupied primarily by minority populace, which lies west of the

Llano River from the remainder of the City. Field investigations accomplished for this study indicated that approximately one-third of the lots in the area were vacant, one-third contained empty deteriorated houses, and one-third were occupied. There are local plans for modification or expansion of the present system to serve the area. Local engineers estimate the collection system expansion costs to be approximately $200,000, including line costs and the necessary pump station to cross the Llano River. With only minor expansion and extensions the remainder of the system should serve the projected population level.

The existing sewage treatment plant for Junction is located east of the City, as shown on Plate 5. The plant, constructed in 1950, has a design capacity of 0.21 mgd and presently serves about 2,500 people. It has been maintained in good physical condition. The plant is of the Imhoff oxidation pond type and consists of a bar screen, Imhoff tank and three oxidation ponds in series. Sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent-Effluent Data (mg/l)

| | TSDH (1971) | TWQB (1970) |
|---|---|---|
| Raw BOD | - | 225 |
| Raw TSS | - | 170 |
| Final BOD | 35 | 10 |
| Final TSS | 48 | 23 |

Sludge disposal consists of utilizing the material as landfill, while effluent from the oxidation ponds is used for the irrigation of fields producing oats and Coastal Bermuda grass. Reportedly, no discharges are released into the Llano River.

The only other discharging waste sources in the area is the cedar oil mill which treats its effluent by holding it in evaporation ponds for settling. Discharge of the effluent is via an open ditch into North Fork Creek which empties into the Llano River.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. Under the present interpretation of this law, land disposal of effluent as practiced by Junction meets all requirements of the law when the disposal is effected in an approved manner and when no effluent is introduced into the surface water or ground water resources either as direct runoff or by direct percolation without adequate treatment time.

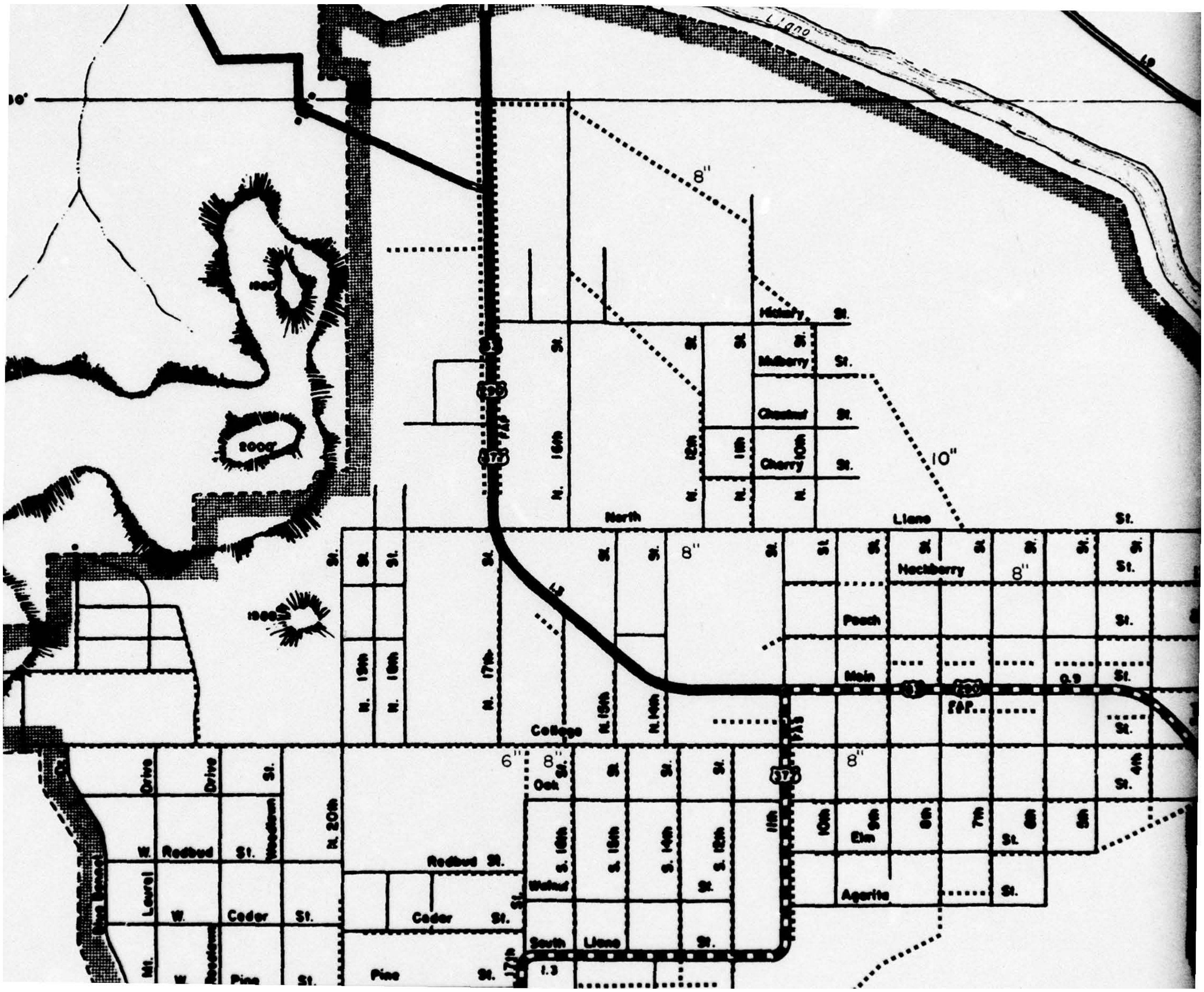
Irrigation with secondary effluent has proven to be an acceptable method of effluent disposal in the semi-arid areas of Texas, while benefitting the local economy and minimizing all adverse impacts on receiving streams that may be associated with a secondary discharge.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Junction wish to implement a discharge, the following items would be required:

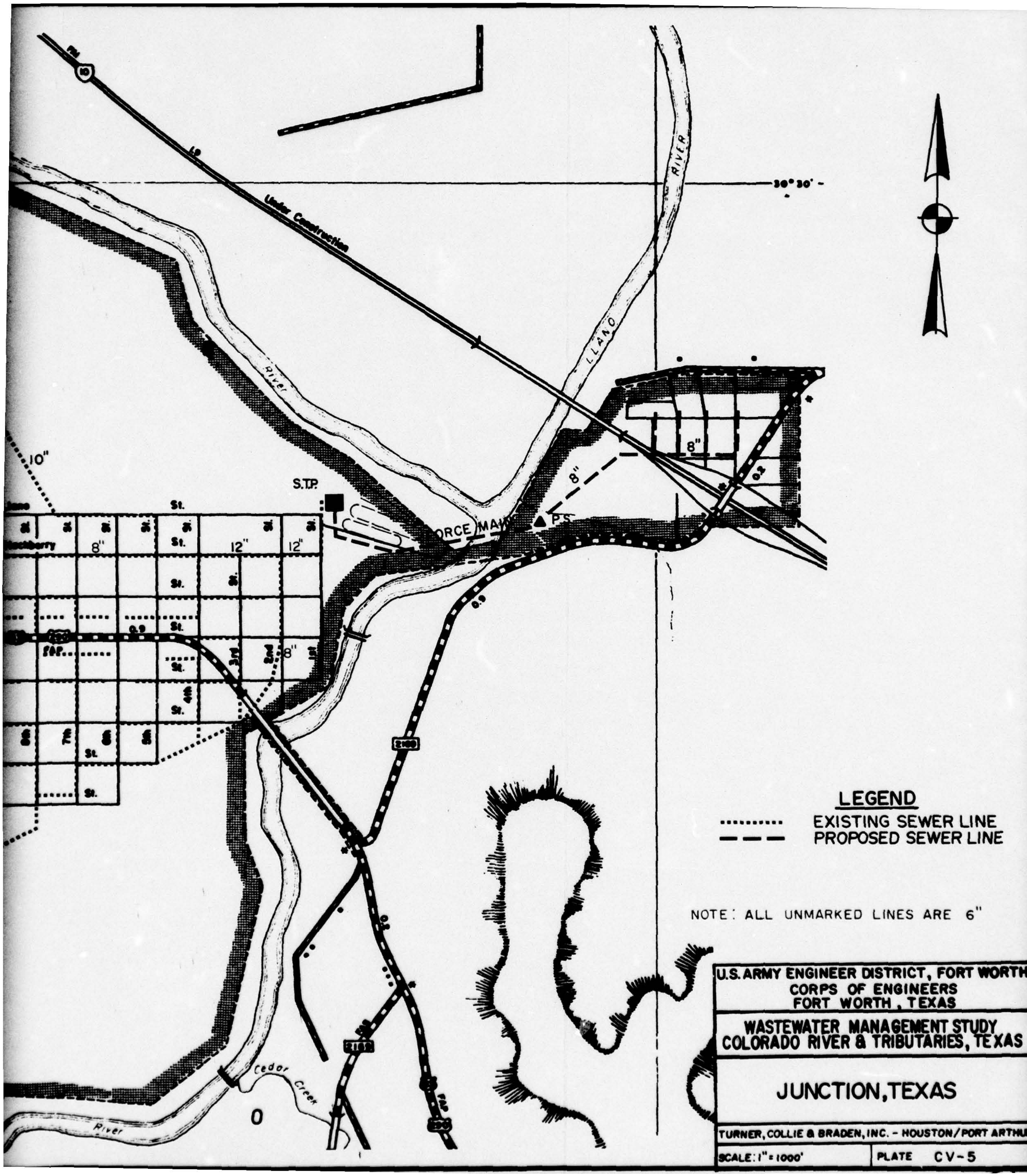
1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $193,100, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $128,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $88,800, including engineering and contingencies.



8"
Hickory St.
Mulberry St.
Chestnut St.
Cherry St.
10"
North Llano St.
8"
Hackberry St.
8"
Peach St.
Main St.
College
6" 8"
Oak
8"
W. Redbud St.
Redbud St.
Elm St.
Walnut
Agarita St.
W. Cedar St.
Cedar St.
South Llano St.
W. Pine St.
Pine St.
N. 20th
N. 19th
N. 18th
N. 17th
N. 16th
N. 15th
N. 14th
N. 12th
11th
10th
9th
8th
7th
6th
5th
4th
S. 16th
S. 15th
S. 14th
S. 12th
Laurel
Drive
2000
1900
1.3
0.9



LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: ALL UNMARKED LINES ARE 6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
JUNCTION, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'
PLATE CV-5
LLANO RIVER
River
Under Construction
S.T.P.
FORCE MAIN
P.S.
Cedar Creek
10"
8"
12"
30° 30'

## AREAWIDE PLAN
## FOR
## MASON, TEXAS

The City of Mason is an incorporated General Law municipality located in the center of Mason County at the intersection of U.S. Highways 377 and 87 and State Highway 29, approximately 110 miles northwest of Austin, Texas. The incorporated area of the City encompasses approximately 1,200 acres. Mason is the county seat of Mason County and is within the jurisdiction of the Concho Valley Council of Governments.

The City has moderate topographic relief and is drained by runoff to Comanche Creek. Comanche Creek runs through the northwest section of town, with most of the City lying west of the creek. The land east of the creek drains to the southwest, and the land west of the creek drains primarily to the east and north.

The City is underlain by soils of the Harley-Pontotoc type. The Harley-Pontotoc soils have generally a friable, slightly acid, sandy loam surface, 10 to 15 inches thick, over firm blockly slightly acid, sandy clay or granular, slightly acid, sandy, clay loam or sandstone. Permeabilities range from 2.0 to 6.3 inches per hour. Septic tanks have only slight limitations in these soils and sewage lagoons have moderate limitations due to the high permeability.

Population data developed by the TWQB for use in this study indicate a rapid decrease in population is expected for Mason over the next fifty years. The population estimates are as follows:

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1806 | 1530 | 1310 | 840 |

The land use is generally typical of that of other small cities, which are characterized by scattered residential development with commercial and public facilities concentrated in the central areas of the City and along major thoroughfares. The economic resource base is primarily agricultural with no significant industrial contribution.

The City is accessible by U.S. Highways 377 and 83 from the north and State Highway 29 from the east and west. Population growth is not anticipated due to the lack of any significant developable resource or anticipated industrial interest.

The municipal water supply is obtained from a ground water source. Four wells of 130, 190, 210 and 380 gpm capacities comprise the water supply with one 0.2 mg storage tank. The projected water use is a reflection of the population trend and has been projected by the TWQB to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.31 | 0.28 | 0.25 | 0.17 |

*Flows in mgd

Municipal wastewater return flows have been projected for Mason by the TWQB to be as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow (mgd) | 0.15 | 0.13 | 0.11 | 0.07 |
| BOD (lb./day) | 310 | 270 | 240 | 160 |
| TSS (lb./day) | 360 | 320 | 290 | 190 |

The existing wastewater collection system is shown on Plate CV-6. It appears that the system is adequate for present needs, and with only minor extensions and additions should serve the future needs of the projected declining population. There are apparently no septic tanks in service in the City and all wastewater except that from swine and cattle feedlots flows to the City's treatment plant. Wastewater from feedlots is allowed to settle in ponds and evaporate so as to allow no discharge.

The existing sewage treatment plant for the City of Mason is located three-quarters of a mile northeast of the intersection of F.M. 1723 and U.S. Highway 87, southeast of the City on a four-acre tract. The plant was built in 1949 with a design capacity of 0.141 million gallons a day and serves a population of approximately 1800. The plant has been maintained in good condition, and in 1969 the oxidation ponds were cleaned and deepened. The plant is of the Imhoff tank type and consists of an Imhoff tank, oxidation ponds and sludge drying beds. Available influent and effluent data published by the TWQB are as follows:

Influent - Effluent Data (mg/l)

| | TWQB 1969 |
|---|---|
| Raw BOD | 170 |
| Raw TSS | 140 |
| Final BOD | 17 |
| Final TSS | 25 |

Dried sludge is used as fill material, and the effluent from the plant is used by a local farmer to irrigate nearby farms and pastures during the summer months. All excess flow is discharged into Comanche Creek, an intermittent tributary of the Llano River.

Under the requirements of PL 92-500, publicly owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal or irrigation of effluent as practiced by Mason meets all requirements when the disposal is carried out in an approved manner and when no effluent is introduced directly into the surface water or ground water resource either as run-off or by direct percolation without adequate treatment.

In order to provide a consistently high level of treatment and to assure compliance with the law, which will in all likelihood define "secondary treatment" by a level of constituents the present oxidation ponds are unable to attain, it is recommended that the City formalize its contract with the local farmer to guarantee continuous withdrawal and expand its irrigation operation to allow year-round disposal.

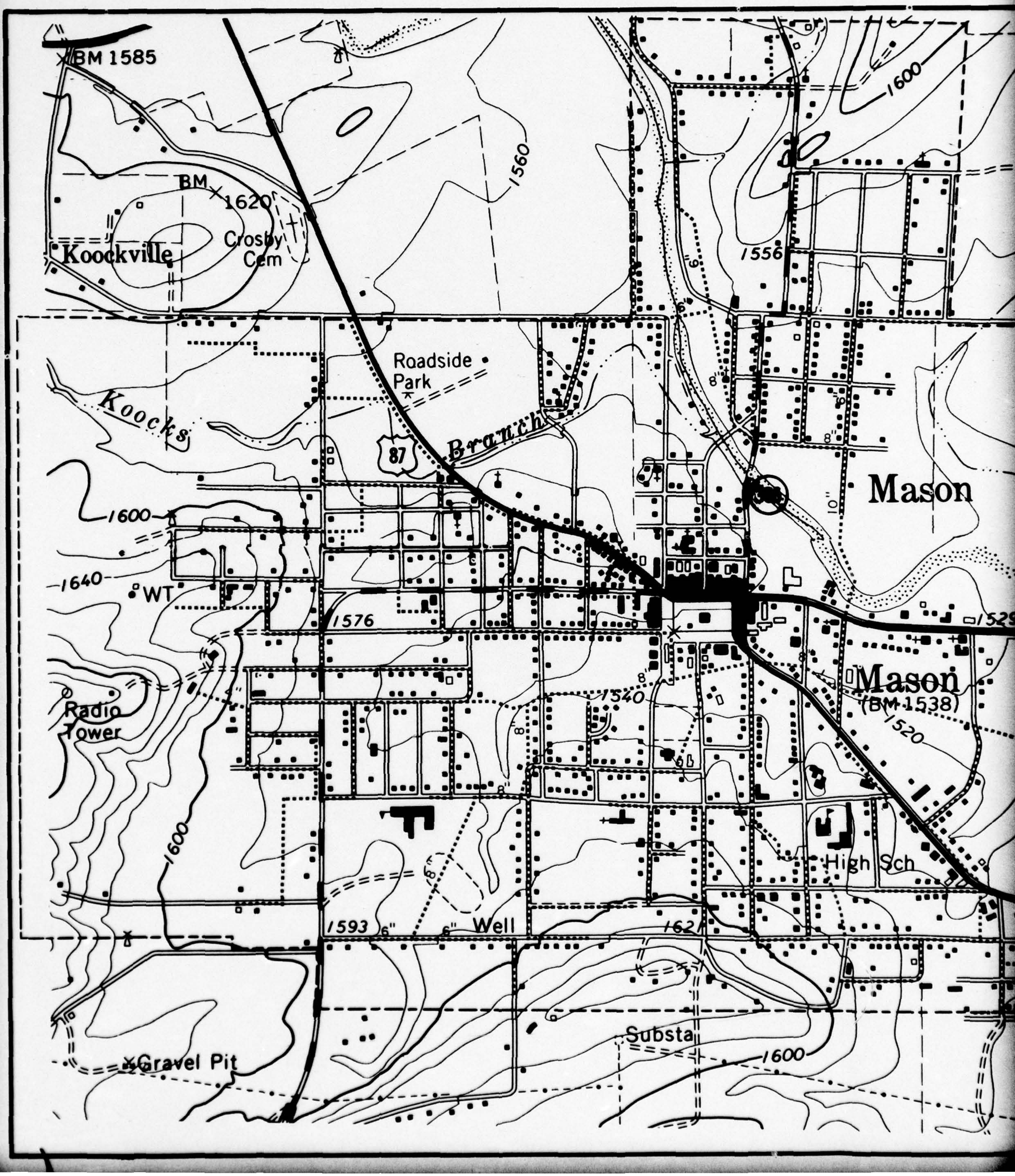
Irrigation will provide a high degree of treatment at relatively low cost while benefitting the local economy and eliminating any adverse impacts on the receiving watercourse caused by the discharge of pond effluent.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Mason wish to implement a discharge, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost $157,400, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $106,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $103,500, including engineering and contingencies.



BM 1585
BM 1620
Koockville
Crosby Cem
1560
1600
1556
Roadside Park
Koocks
Branch
87
Mason
1600
1640
WT
1576
1529
Mason
(BM 1538)
1540
1520
Radio Tower
1600
High Sch
1593
Well
1620
Substa
1600
Gravel Pit


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MASON, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'

PLATE CV-6

## AREAWIDE PLAN
## FOR
## BRADY, TEXAS

The City of Brady, an incorporated general law municipality, is located in the south central portion of McCulloch County at the intersection of U.S. Highways 87, 190 and 377, approximately 150 miles northwest of Austin, Texas. The incorporated area encompasses approximately 1,650 acres. Brady, the county seat of McCulloch County, is located within the jurisdiction of the Concho Valley Council of Governments.

The town is divided into northern and southern portions by Brady Creek which drains the area. The northern portion, which varies in elevations approximately 40 feet, drains predominantly to the southwest into Live Oak Creek and Brady Creek. The southern portion, with greater topographic relief and elevations varying approximately one hundred feet, drains to the north into Brady Creek.

The City is predominantly underlain by soils of the Mereta-Valera type. These soils, generally 8-12 inches thick, are characterized by a calcareous loam to clay loam surface. Underlying the loam is a hard rocklike caliche layer over a hard limestone bedrock or a bed of limestone fragments interbedded with semi-hard caliche, both of which occur at about 15-35 inches below the soil surface. Permeabilities range from 0.2 - 0.6 inch per hour, imposing severe limitations on both septic tanks and sewage lagoons due to the shallow depth of the bedrock and the strongly cemented caliche layer.

Population data developed by the TWDB for use in this study indicated that a moderate decrease in population is expected for Brady over the next fifty years. The population estimates are as follows:

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 5,557 | 5,130 | 4,600 | 3,040 |

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration

of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some industrial contribution--specifically, several sand processing plants and a wool processing plant. Accessible by three U.S. Highways, Brady is served by the Atchison, Topeka and Santa Fe Railroad.

The municipal water supply consists solely of ground water supplies drawn by five wells with capacities of 700, 800, 1,000, 1,050 and 1,100 gpm, and stored in four ground reservoirs, three with capacities of .020 mg and one with 1.0 mg capacity, and two elevated storage reservoirs with capacities of 0.50 mg and .015 mg. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 1.34 | 1.23 | 1.11 | 0.73 |
| Industrial Use: | 0.42 | 0.44 | 0.47 | 0.59 |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.47 | 0.44 | 0.39 | 0.26 |
| BOD in lb/day: | 940 | 920 | 830 | 580 |
| TSS in lb/day: | 1,100 | 1,080 | 1,010 | 700 |

The existing wastewater collection system is illustrated on Plate CV-7. The system is apparently adequate for present needs, and with minor expansions and additions will meet the future needs of the declining population. There is apparently only one area of town to the northwest where septic tanks are still the primary means of sewage disposal. The area is low-lying and could require an additional lift station to provide service. Utilizing an 8-inch interceptor run against natural grade to the existing pump station, it is estimated the expansion to the system to serve the low-lying area would cost approximately $27,000, including $11,040 for 1,100 feet of 6-inch sewer line and $5,960 for 500 feet of 8-inch sewer line.

Brady's existing sewage treatment plant is located east of the City on the west bank of Brady Creek. The plant, constructed in 1964, has a design capacity of 1.0 mgd, presently serves about 6,000 people, and is maintained in very good physical condition. The plant is of the high-rate trickling filter type, consisting of an aerated grit chamber, Parshall flume, primary and final clarifiers, two trickling filters, a digestor, and sludge drying beds. Available sampling data published by the Texas State Department of Health and Texas Water Quality Board are as follows:

Influent and Effluent Data (mg/l)

| | TSDH (1972) | TWQB (1972) |
|---|---|---|
| Raw BOD | 110 | 110 |
| Raw TSS | 100 | 95 |
| Final BOD | 13 | 13 |
| Final TSS | 13 | 13 |

Sludge disposal consists of hauling the material to the golf course for fertilizer, or to a sanitary landfill. Effluent from the final clarifier is utilized to irrigate Coastal Bermuda grass for five months of the year and is discharged into Brady Creek the remainder of the year.

Other than sand and gravel operations, the only industrial wastewater source in the area is Roddy Wool. The company treats its effluent

by discharging the wool wastewater into evaporation pits from which no final discharge is allowed.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and "the best practicable waste treatment technology" by 1983. According to the present interpretation of the law, land disposal of effluent as practiced by Brady meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or percolation without adequate treatment time.

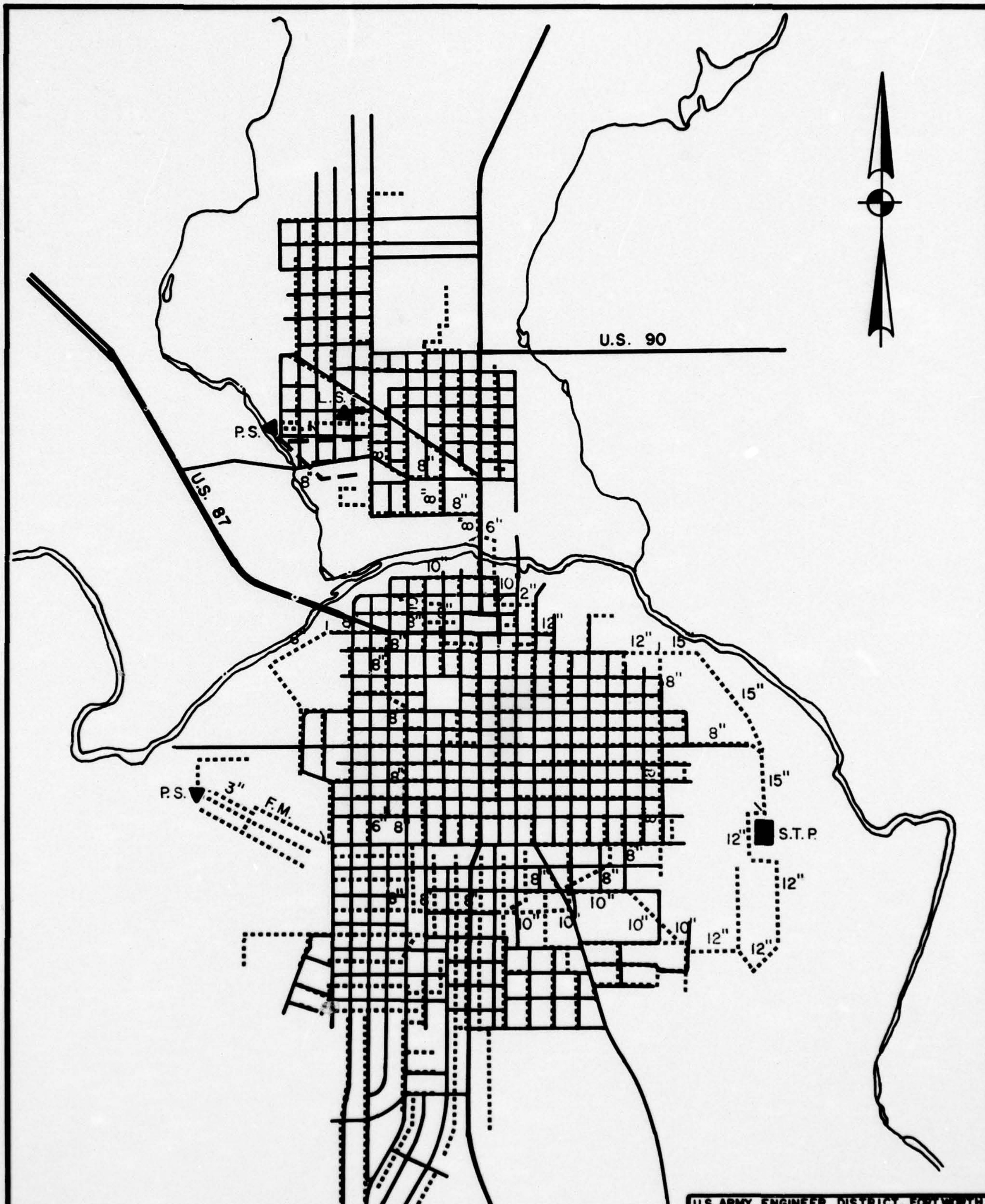
The existing secondary treatment facility is adequate in capacity to serve the City throughout the planning period. To meet the future additional treatment level requirements, it is proposed the City expand its irrigation operation into a year-round practice. The irrigation method of disposal has proven an acceptable method of treatment in the semi-arid areas of Texas and has proven to be a valuable reuse of the available water resource while eliminating any adverse impacts on the receiving watercourse.

It is recommended that the aforementioned annual no-discharge plan be undertaken. However, should the City of Brady wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $346,700, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $178,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $167,000, including engineering and contingencies.




## LEGEND

········· EXISTING SEWER LINES
— — — PROPOSED SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

**BRADY, TEXAS**

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

| | |
|---|---|
| SCALE: 1" = 2000' | PLATE: CV-7 |

## AREAWIDE PLAN
## FOR
## MENARD, TEXAS

The City of Menard is an incorporated general law municipality located in the north central portion of Menard County at the intersection of U.S. Highway 83 and State Highway 29, approximately 150 miles northwest of Austin, Texas. The incorporated area of the City encompasses approximately 700 acres. Menard, the county seat of Menard County, is within the main jurisdiction of the Concho Valley Council of Governments.

Menard is situated in the valley of the San Saba River, which also divides the City into northern and southern portions. The southern part of the City slopes and drains to the north. The northern portion drains to the south. The extreme southern part of Menard rises up and along a valley into the hills which encircle its southern edge. It is the only part of the City exhibiting any great topographic relief.

The City is predominantly underlain by soils of the Frio-Uvalde types. These soils, generally 15-25 inches thick, have a calcareous loam to silty clay surface underlain by a strongly calcareous, crumbly, clay loam over stratified gravelly and sandy sediments. Permeabilities range from 0.63 - 2.0 inches per hour, causing no or only slight limitations for septic tanks. The other soil type in the area is the Tarrant stony soil which is on the northern and southern edges of town. This soil is generally 4 to 8 inches thick with a highly calcareous clay surface over broken or partly weathered limestone or limestone bedrock at less than twelve inches beneath the surface. Permeabilities range from 0.2 to 0.6 inch per hour. Septic tanks and sewage lagoons have severe limitations due to the shallow depth of the bedrock.

Population data developed by the TWDB for use in this study indicate that a slight decrease in population is expected for Menard over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,740 | 1,650 | 1,550 | 1,130 |

Land use for the City, typical of that of other small towns, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil-field activity; however, there is no significant industrial contribution.

The City, accessible by Highways 83 and 29, is served by the Atchison, Topeka, and Santa Fe railroad. Population growth is not anticipated due to the lack of any forseeable industrial interest of developable natural resource.

The municipal water supply is obtained from four 26-foot-deep wells with pumping units of 125, 150, 150, and 175 gpm capacity and one 250 gpm surface water pump at the San Saba River supply water to the system. Storage is provided by a concrete ground tank and a steel elevated storage reservoir with capacities of 0.140 mg and 0.200 mg respectively. The projected water use, a reflection of the population trend, has been developed by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.29 | 0.32 | 0.32 | 0.29 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd | 0.15 | 0.14 | 0.13 | 0.10 |
| BOD in lb./day | 300 | 300 | 280 | 210 |
| TSS in lb./day | 350 | 350 | 340 | 260 |

The only known permitted industrial discharge in the vicinity is for a local commission company which maintains a 35,000-head sheep feedlot. The permit allows no discharge except under extreme storm conditions. Runoff from the lots is captured in ponds and allowed to evaporate.

The existing wastewater collection system is shown on Plate CV-8. As can be seen from the exhibit, a significant portion of the City relies on septic tanks as the primary means of sewage disposal. At the present time, there are approximately 270 sewer connections as compared to 750 water connections in the City. Field visitations revealed no specific interest in or plans for abandonment of the septic tanks or extension of service. If it is decided to provide service to these areas, the proposed collection system detailed on Plate CV-8 should adequately serve the need. It is estimated the total project cost for this expansion would be approximately $503,000, including engineering and contingencies.

The existing sewage treatment plant of Menard is located on the south side of the San Saba River on the western boundary of the City as shown on Plate CV-8. The plant is of the trickling filter type and consists of a grit chamber, Imhoff tank, trickling filter, three oxidation ponds, and sludge drying beds. The original plant was constructed in 1953 and consisted of the Imhoff tank and oxidation pond In 1972, the trickling filter and two additional oxidation ponds were added in series to the treatment scheme. Available sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (1971) | TWQB (1968) |
|---|---|---|
| Raw BOD | - | 130 |
| Raw TSS | - | 153 |
| Final BOD | 60 | 50 |
| Final TSS | 70 | 123 |

Waste sludges are utilized as fertilizer, and effluent from the final oxidation pond is discharged into the San Saba River. Evaporation and

exfiltration from the ponds frequently exceeds the plant inflow such that no surface discharge occurs from the ponds. Other than the aforementioned feedlot, there are no other known waste sources in the area.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the level of parameters that will be used to define "secondary treatment" will not be attainable by the treatment process presently utilized by Menard.

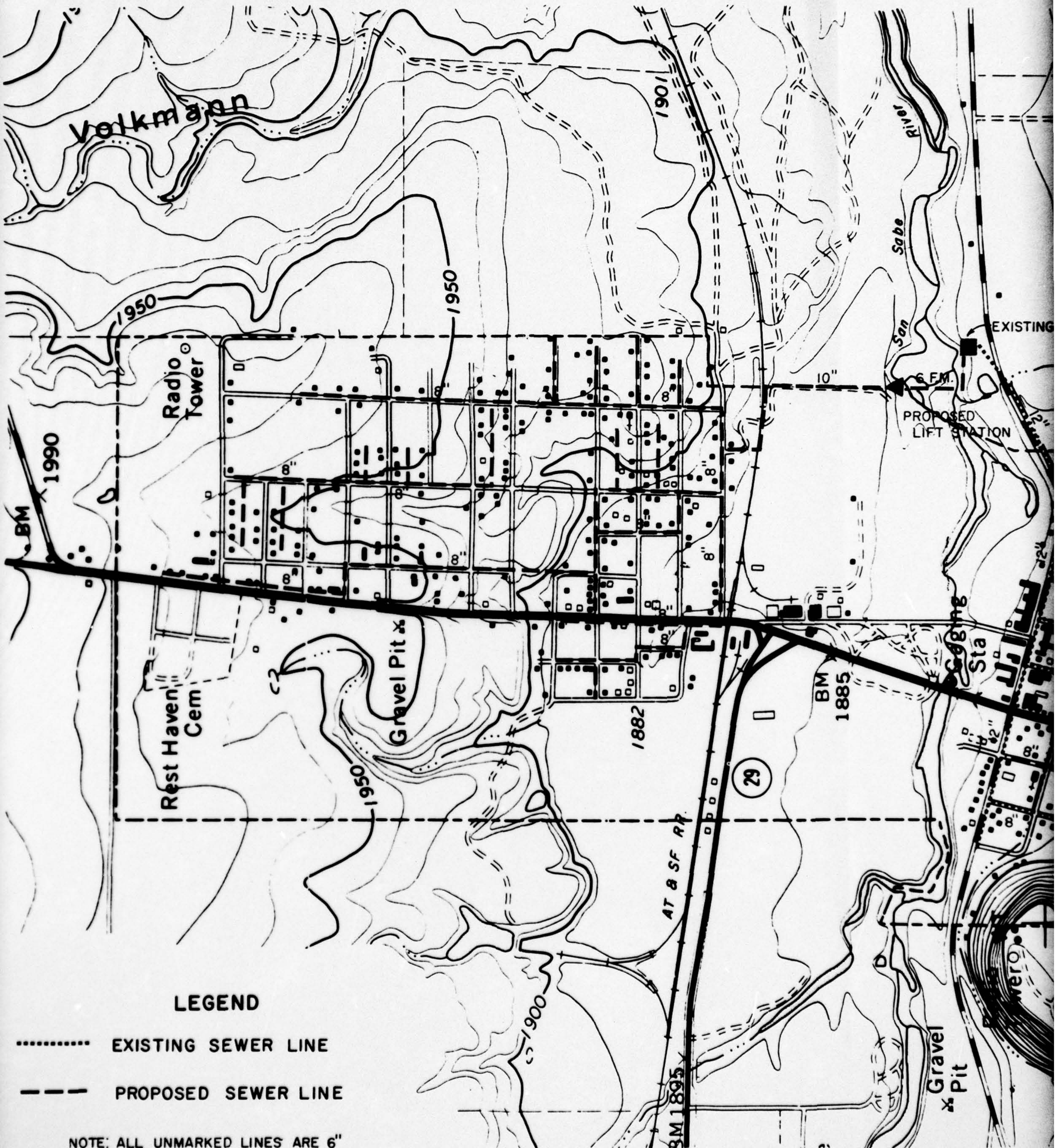
Costs to provide conventional facilities to meet this requirement would be prohibitive for a city of Menard's size. However, if a suitable site can be found, irrigation with secondary effluent would prove an efficient and practical method to provide a high degree of treatment that would not only meet 1977 requirements but would meet the additional best available treatment requirements of 1983. Examination of existing irrigation site areas provided by the General Land Office indicates that irrigation is practiced in several areas along the San Saba River west of the city limits. Prior to 1977 the City should investigate contracting with the local irrigators and deliver all effluent to them for their use. This method of disposal will not only provide a high degree of treatment for the wastewater, but will provide maximum reuse of a valuable resource in an arid area.

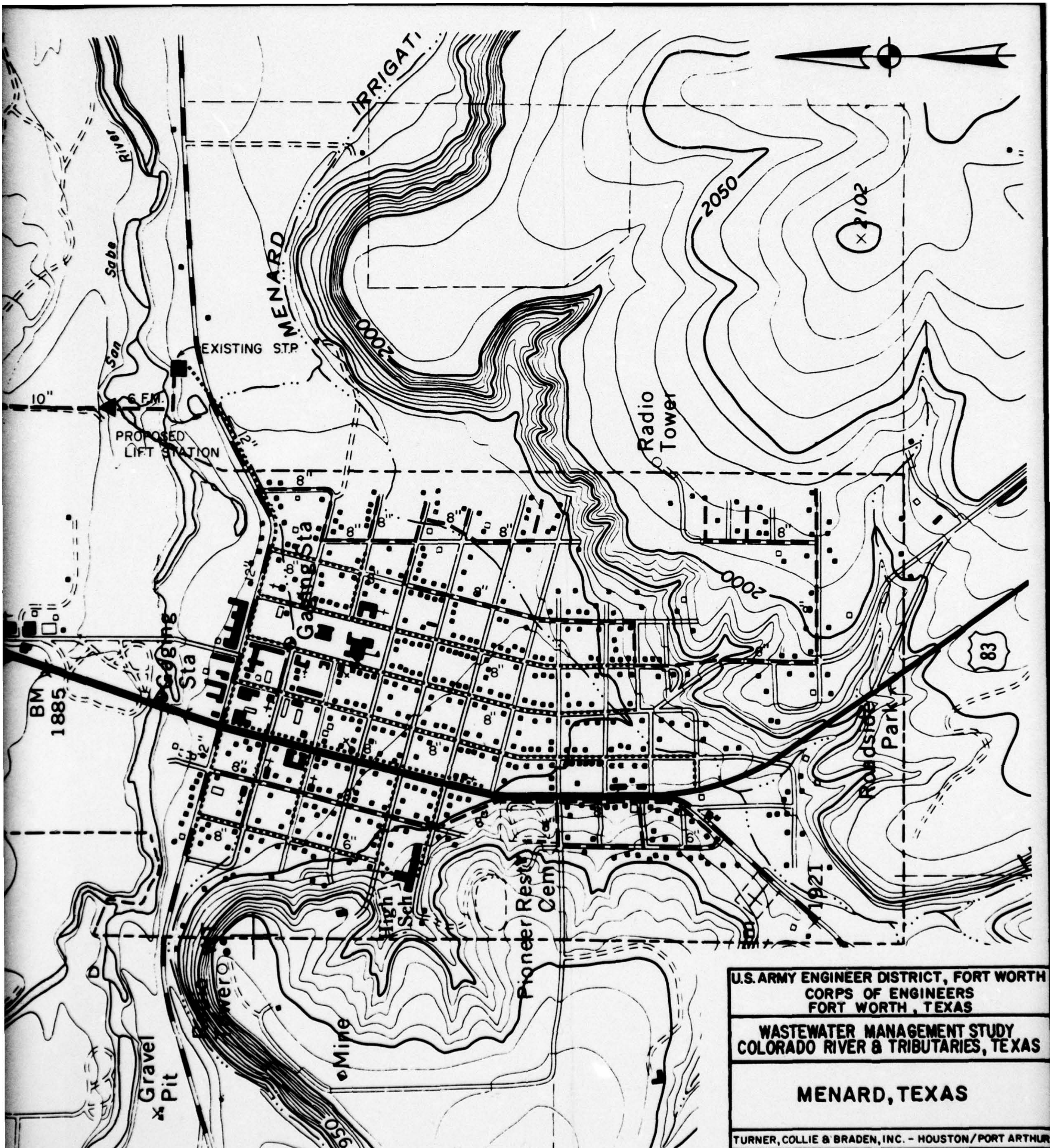
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the city of Menard wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $139,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $105,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $99,000, including engineering and contingencies.


Volkmann
1950
1990
BM
Radio Tower
1901
San Saba River
EXISTING
10"
6 F.M.
PROPOSED LIFT STATION
8"
12"
Rest Haven Cem
Gravel Pit
1882
BM 1885
29
AT & SF RR
Gaging Sta
1900
BM 1895
Gravel Pit
LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: ALL UNMARKED LINES ARE 6"




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MENARD, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

| | |
|---|---|
| SCALE: 1" = 1000' | PLATE CV-8 |

# AREAWIDE PLAN
# FOR
# BIG LAKE, TEXAS

The City of Big Lake is an incorporated general law municipality located in the south portion of Reagan County east of the intersection of U.S. Highway 67 and State Highway 137, approximately 72 miles southwest of San Angelo, Texas. The incorporated area of the City encompasses approximately 560 acres. Big Lake is the county seat of Reagan County and is located within the Concho Valley Council of Governments.

The City has little topographical relief and is drained by two creeks, one north of town and the other southwest of town. The area generally drains to the southwest. The City is underlain by soils of the Reagan series. The Reagan soils are generally characterized by a friable calcareous silty clay loam to silty loam surface, 6 to 12 inches thick, over friable, granular, silty, clay loam. At depths of 30 to 48 inches beneath the surface, there is soft friable chalky material containing 50 to 70 percent calcium carbonate. Permeabilities range from 0.63 to 2.0 inches per hour. Septic tanks have only slight limitations due to the favorable permeability.

Population data developed by the TWDB for use in this study indicate a rapid decrease in population for Big Lake over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 2,489 | 2,210 | 2,000 | 1,250 |

The land use for Big Lake is typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities in the central areas of town and along the major thoroughfares. The economic resource base is primarily cattle and sheep ranching with contributions from local oil field activity. Big Lake serves as the center for oil activities and ranching trade. There are two gasoline plants which also contribute to the local economy.

The City is accessible by Highway 137 and 67 and is served by the Atchison, Topeka, and Santa Fe Railroad. Population growth is not anticipated due to the remote location and lack of any developable resource or other positive economic factors.

The municipal water supply is obtained from ground water sources and is distributed by the Reagan County Water Supply District which maintains 13 wells located 22 miles north of town. Storage for the system is provided by four storage tanks: one 0.4-mg ground storage tank at the well field, two 1.0-mg ground storage tanks at the north city limits, and one 0.25-mg elevated reservoir within the City. The expected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.38 | 0.36 | 0.35 | 0.26 |
| Industrial Use: | None | None | None | None |

*Flow in mgd

Municipal wastewater return flows have been projected for the City by the TWDB to be as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd | 0.21 | 0.19 | 0.17 | 0.11 |
| BOD in lbs./day | 420 | 400 | 360 | 240 |
| TSS in lbs./day | 500 | 460 | 440 | 290 |

The existing wastewater collection system is shown on Plate CV-9. It appears that the system is adequately serving the needs of the City. There are apparently no significant areas which rely on septic tanks for sewage disposal. With only minor extensions and additions, the present system should be able to meet the needs of the projected declining population.

The existing sewage treatment plant for the City of Big Lake is located near the eastern city limit as shown on Plate CV-9. The plant was built in 1954 with a design capacity of 0.375 mgd and currently serves a population of approximately 2,500 people. The plant is of the Imhoff-Oxidation Pond type and has apparently been well maintained. The plant consists of a bar screen, an Imhoff tank, oxidation ponds, and sludge drying beds. Available sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (1972) | TWQB (1972) |
|---|---|---|
| Raw BOD | 270 | 270 |
| Raw TSS | 480 | 482 |
| Final BOD | 30 | 30 |
| Final TSS | 60 | 60 |

Sludge from the plant is used as a fertilizer and the effluent from the plant is used for irrigation of the municipal golf course. During portions of the year when the golf course isn't irrigated, the effluent is discharged into a dry ditch which flows into Big Lake, a playa lake bed southeast of the City. An examination of maps depicting the drainage pattern of the area indicates that the lake is without outlet and as such is non-contributory to the Colorado River.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the effluent constituent levels which will be established to define secondary treatment will not be attainable by an

Imhoff-Oxidation pond type of facility such as Big Lake maintains. The City is, however, in full compliance with the law when it utilizes effluent for irrigation, a method of disposal which is capable of providing a high level of treatment to the wastewater. For the purposes of this study, it is assumed that the discharge of effluent into the dry lake bed to evaporate is also in compliance since no discharge of pollutants is allowed to reach a tributary of the Colorado River.

It therefore appears no modifications or improvements to the treatment facilities are required other than routine maintenance and replacement. Although the present facilities are twenty years old, they have been maintained in good condition and little investment is likely to be needed in the future.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Big Lake wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $193,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $122,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $84,000, including engineering and contingencies.

AD-A036 849 ARMY ENGINEER DISTRICT FORT WORTH TEX F/G 13/2

WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)

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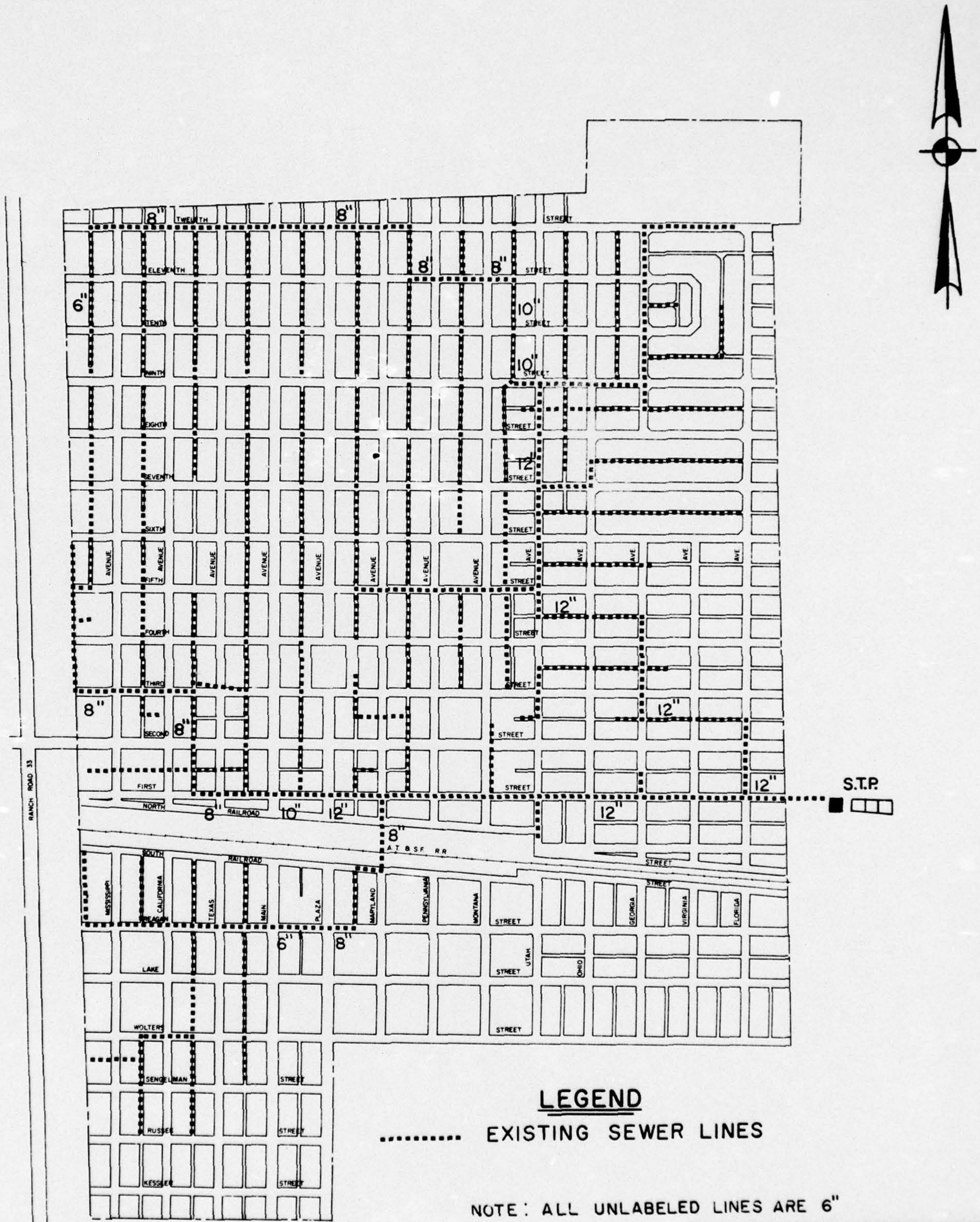



## LEGEND

·········· EXISTING SEWER LINES

NOTE: ALL UNLABELED LINES ARE 6"

| |
|---|
| U.S. ARMY ENGINEER DISTRICT, FORT WORTH<br>CORPS OF ENGINEERS<br>FORT WORTH, TEXAS |
| WASTEWATER MANAGEMENT STUDY<br>COLORADO RIVER & TRIBUTARIES, TEXAS |
| **BIG LAKE, TEXAS** |
| TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR |
| SCALE: 1" = 1000'    PLATE: CV-9 |

## AREAWIDE PLAN
## FOR
## ELDORADO, TEXAS

The City of Eldorado is an incorporated general law municipality located in the central portion of Schleicher County at the intersection of U.S. Highway 277 and State Highway 29, approximately 45 miles south of San Angelo, Texas. The incorporated area of the City encompasses 540 acres. Eldorado, the county seat of Schleicher County, lies within the jurisdiction of the Concho Valley Council of Governments.

The City has little topographic relief, with ground elevations varying 30 feet draining northeast to the Concho River.

The Valera-Tobosa soil primarily underlies the City. This soil type, generally 8 to 12 inches thick, has a crumbly calcareous clay surface over a massive calcareous clay underlain by hard caliche coated limestone bedrock. Permeabilities are less than 0.06 inch per hour. Septic tanks and sewage lagoons have severe limitations due to the slow permeabilities and the shallowness of the bedrock.

The Tarrant soil, bordering the City to the north, is four to eight inches thick with a highly calcareous stony clay surface over broken or partly weathered limestone or limestone bedrock at less than twelve inches beneath the surface. Permeabilities range from 0.2 to 0.6 inch per hour. Septic tanks and sewage lagoons again have severe limitations due to the shallowness of the bedrock.

Population data, developed by the TWDB for use in this study, indicate that a moderately rapid decrease in population is expected for Eldorado over the next fifty years. The population estimates are as follows:

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,446 | 1,340 | 1,070 | 590 |

The land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration

of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily ranching with contribution from local oil-field activity; however, there is no known significant industrial contribution.

The City, accessible by highways 277 and 29, is served by the Santa Fe Railroad. Population growth is not anticipated as a result of a lack of industrial interest or developable natural resource and outward migration to the nearby metropolitan area of San Angelo.

The municipal water supply is obtained from a ground water source consisting of four wells of 325, 350, 375 and 400 gpm capacities. Storage for the system is provided by a ground reservoir and an elevated reservoir with capacities of 0.50 mg and 0.05 mg respectively. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.18 | 0.18 | 0.15 | 0.09 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as presented below. There are no known industrial point sources of pollution in the vicinity.

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd | 0.12 | 0.11 | 0.09 | 0.05 |
| BOD in lb. /day | 250 | 240 | 190 | 110 |
| TSS in lb. /day | 290 | 280 | 230 | 140 |

Sewage line layout records were destroyed in a City hall fire; therefore Plate CV-10 showing existing lines is the best approximation that could be made from local interviews and unofficial records. Apparently the system is adequate for present needs and, with minor extensions, should meet the future needs of the declining population. The only area of town where septic tanks remain the primary means of sewage disposal is in the northeast corner of the city limits. The area, however, has degenerated to an extreme, and a large portion of the populace has moved elsewhere in the City. It is estimated it would cost approximately $104,700, including engineering and contingencies, to add this area to the existing system.

The existing sewage treatment plant, located at the eastern city limit, as shown on Plate CV-10, was constructed in 1946 with a design capacity of 0.072 mgd and presently serves a population of approximately 1200. The facility appears to have been maintained in fair physical condition; however, as evidenced by the field investigations, the Imhoff gas vents were choked with scum and daily maintenance was not being performed. The plant is of the Imhoff-oxidation pond type and consists of an Imhoff tank, an oxidation pond, and an irrigation holding pond. Available sampling data published by the Texas State Department of Health and TWQB is as follows:

Influent - Effluent Data (mg/l)

| | TSDH (1971) | TWQB (1969) |
|---|---|---|
| Raw BOD | - | 220 |
| Raw TSS | - | 227 |
| Final BOD | 20 | 9 |
| Final TSS | 80 | 10 |

Sludge disposal consists of using the material for fill, and effluent from the final oxidation pond is utilized for irrigation about five months out of the year.

According to the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977, and the best practicable waste treatment technology by 1983. According

to the present interpretation of this law, land disposal of effluent as practiced by Eldorado meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced untreated into the surface water or ground water resources either as runoff or by direct percolation.

Preliminary calculations indicate that a storage capacity of approximately 50 acre-feet would be required to hold all municipal effluent during the seven-month period when irrigation is not utilized. The present oxidation pond and irrigation reservoir have a combined surface area of approximately six acres. Allowing for net evaporative losses and assuming a maximum depth of five feet for the oxidation pond and assuming an average depth of five feet for the holding pond, the reservoirs would have just enough capacity to prevent discharge through the winter months. These calculations and assumptions should be verified locally, and if sufficient storage is not available steps should be taken to provide sufficient storage volume. For the seven month period when irrigation is not utilized.

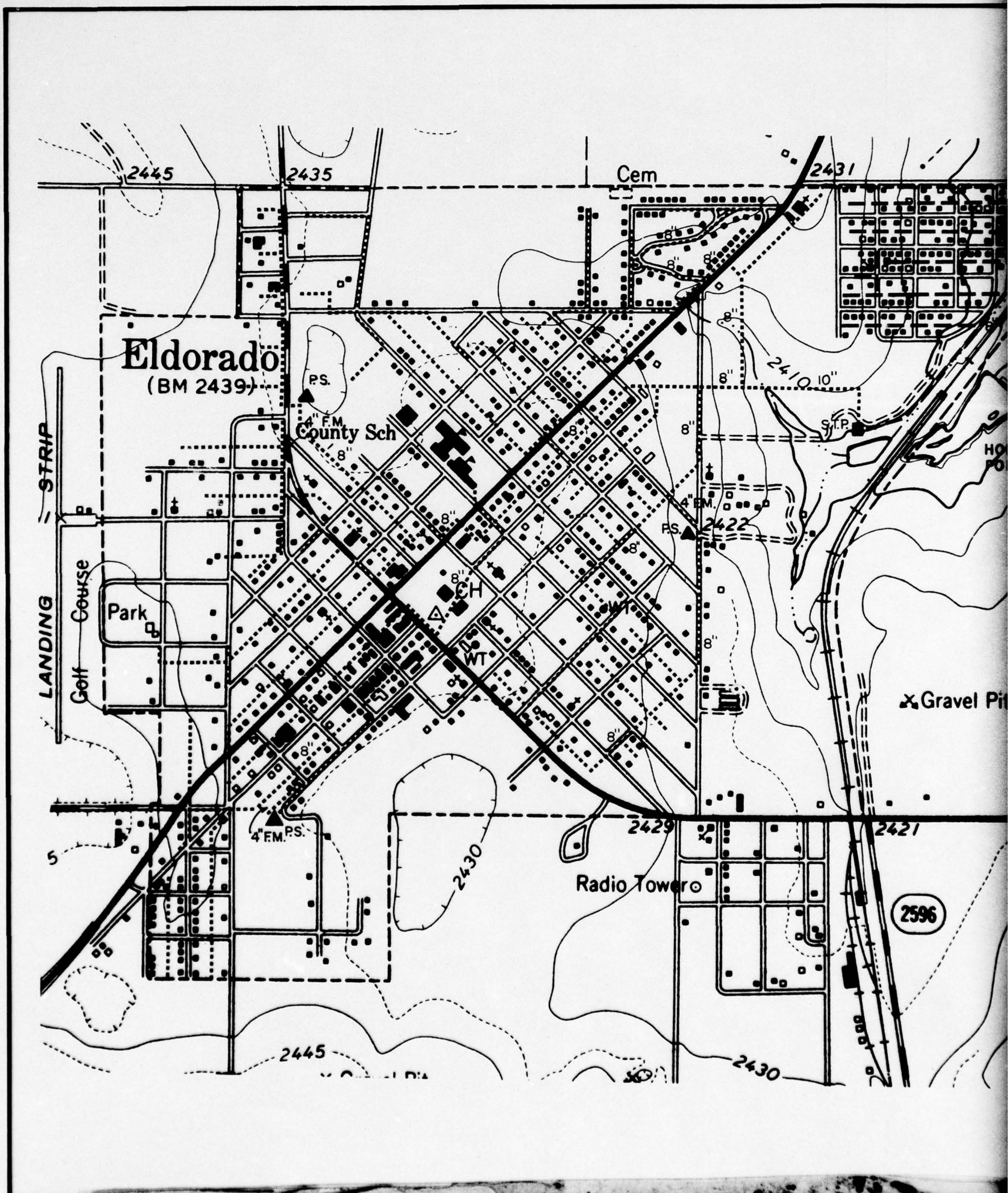
No proposals are offered therefore to upgrade the level of treatment practiced at Eldorado. It is recommended, however, that the City upgrade its daily maintenance procedures to allow the units to function properly and avoid any nuisance odors associated with improper maintenance.

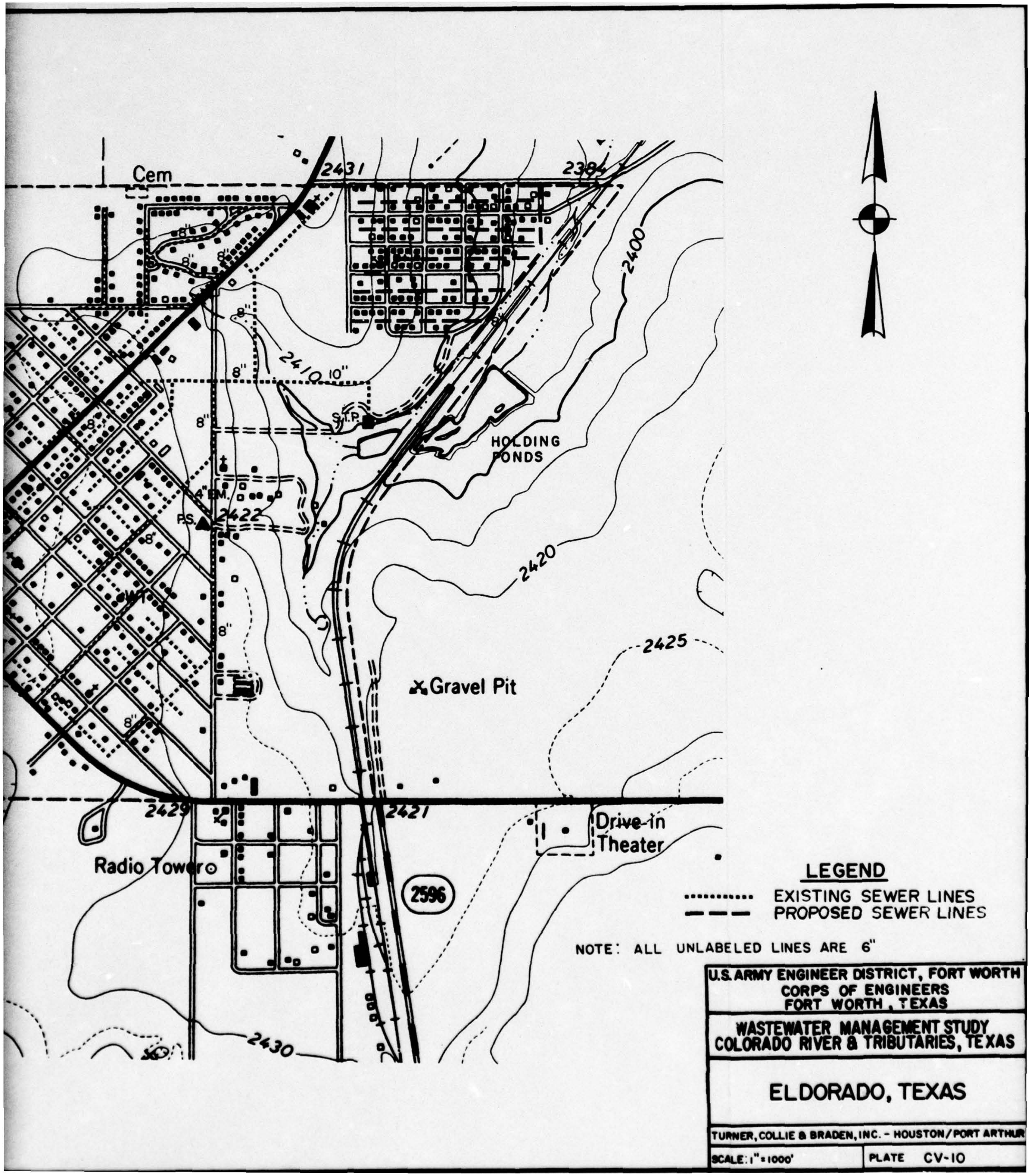
It is recommended that the aforementioned no-discharge plan be undertaken on an annual basis. However, should the City of Eldorado wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $95,200, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $87,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification further phosphorus reduction facilities at an approximate capital cost of $81,000, including engineering and contingencies.


Eldorado
(BM 2439)
Cem
2445
2435
2431
2410
P.S.
4" F.M.
County Sch
STRIP
LANDING
Golf Course
Park
CH
WT
P.S.
2422
4" F.M.
S.T.P.
Gravel Pit
2429
2421
2430
Radio Tower
2596
2445
2430
5



Cem
2431
2384
2400
2410
10"
8"
S.T.P.
HOLDING PONDS
4"F.M.
P.S.
2422
2420
W.T.
2425
Gravel Pit
2429
2421
Drive-in Theater
Radio Tower
2596
2430
LEGEND
EXISTING SEWER LINES
PROPOSED SEWER LINES
NOTE: ALL UNLABELED LINES ARE 6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
ELDORADO, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'
PLATE CV-10

AREAWIDE PLAN
FOR
STERLING CITY, TEXAS

Sterling City, an incorporated general law municipality, is located in the central portion of Sterling County at the intersection of U.S. Highway 87 and State Highway 163, approximately 40 miles northwest of San Angelo, Texas. The incorporated area of the City encompasses about 2,500 acres. Sterling City is the county seat of Sterling County and is under the jurisdiction of the Concho Valley Council of Governments.

The topographic relief of the City is moderate with the ground generally sloping in a north to south direction. A small tributary creek of the North Concho River, which borders the City on the south, flows through the central portion of Sterling City providing drainage.

The City is underlain by Rowena and Mereta soils. The Rowena soil has a friable, calcareous, clay loam to light clay surface, generally six to ten inches thick, over a friable, subangular, blocky, calcareous, light clay that grades into a firm, blocky clay underlain by soft caliche. Mereta soils have a friable, calcareous loam to clay loam surface, generally eight to twelve inches thick over friable, granular, strongly calcareous, silty clay or clay loam. A hard, rock-like, caliche layer underlies the clay. Permeabilities range from 0.2 to 0.63 inch per hour for both soils. There are severe limitations on septic tanks due to the shallow depth to bedrock.

Population data, developed by the TWDB for use in this study, indicate that a moderate decrease in population is expected for Sterling City over the next fifty years. The population estimates are as follows:

<u>Population Projections</u>

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 780 | 690 | 620 | 490 |

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the

central areas of the City. The economy is based primarily on ranching, with some contribution from local oil field activity. There is no known industrial contribution; however, the City does have a hospital and a nursing home which contribute to the local economy.

Accessible by U.S. Highway 87 and State Highway 163, the City is not served by a railroad system. Population growth is not anticipated for Sterling City due to a lack of plentiful water supply, developable natural resources, or industrial interest.

The municipal water supply is obtained solely from ground water sources. The water is provided by three wells, all 200 feet deep, utilizing one 300-gpm service pump and two 35-gpm standby pumps. Storage is provided by 500,000-gallon elevated steel reservoir. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.06 | 0.06 | 0.05 | 0.05 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd: | 0.07 | 0.06 | 0.05 | 0.04 |
| BOD in lb./day: | 133 | 124 | 112 | 93 |
| TSS in lb./day: | 156 | 145 | 136 | 113 |

The City has no existing wastewater collection system. Septic tanks are utilized throughout the City; however, they aren't a viable means of disposal because of the shallow depth of the rock hard caliche layer. According to prior reports, the City has gone forward with a financial assistance application for construction of a collection and treatment system similar to that depicted on Plate CV-11.

Since details of the proposed system are not available and were not furnished upon request by the City, and no land use, line sizes, or topographic information is available, even a cursory review of the collection schematic in relation to the present inhabited area cannot be accomplished. It is also not known what treatment method is proposed in the financial application; however, it would be the recommendation of this study that the method be an activated sludge secondary treatment process operated in either the extended aeration or contact-stabilization mode.

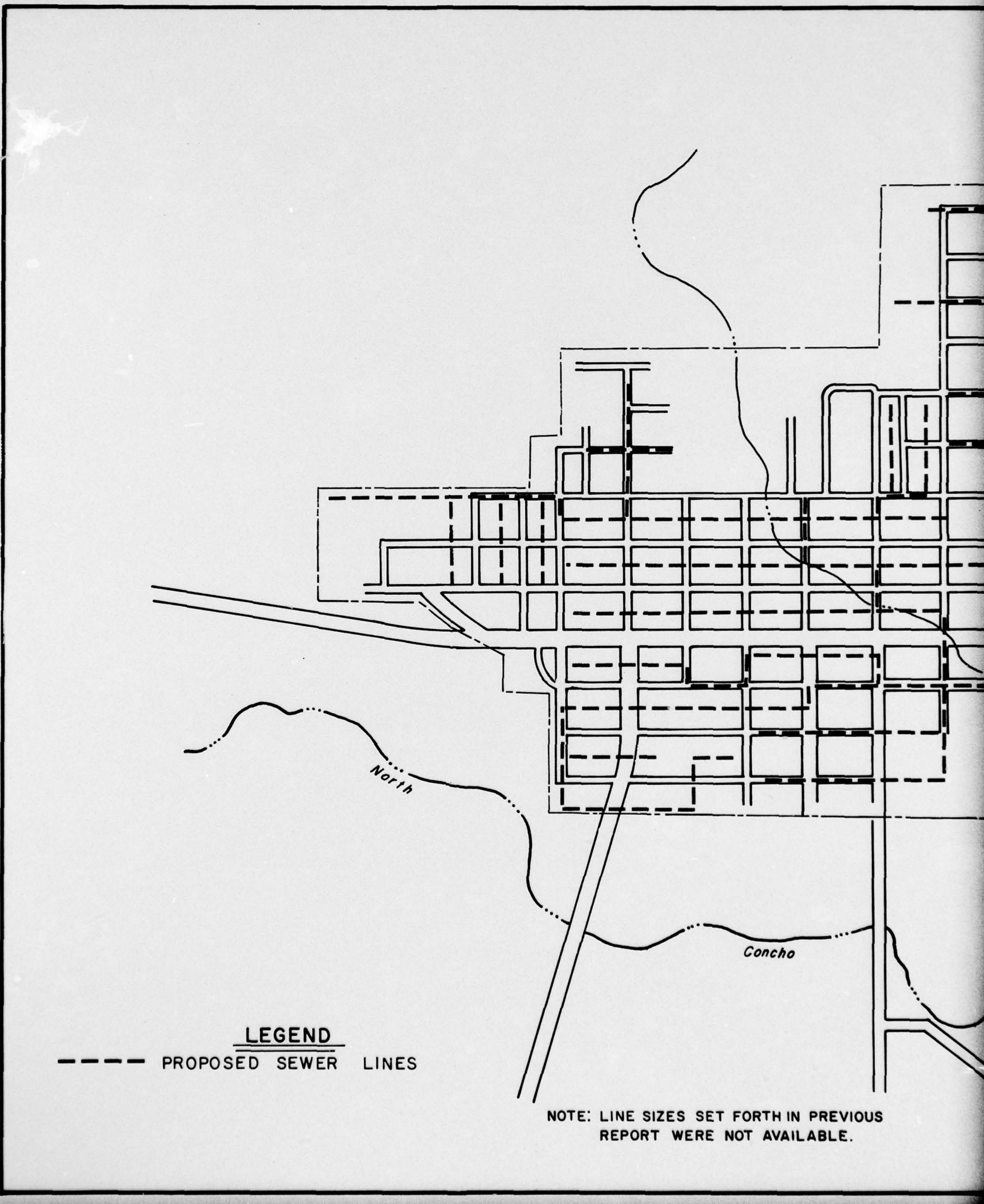
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the parameters which will be established to define secondary treatment will be attainable by an activated sludge process. To be in compliance with the 1983 requirements, it is proposed the City utilize irrigation for final effluent disposal. Disposal by irrigation has proven to be an efficient method of bringing about a high degree of final treatment while providing optimum reuse of a scarce resource. Reference to irrigation data obtained from the General Land Office indicates several present irrigation sites in close proximity to Sterling City. It is therefore proposed the City enter into agreement with these irrigators to supply them with secondary effluent, with the condition that irrigation be practiced year-round or adequate storage be provided to avoid discharge. It is estimated the activated sludge plant would cost approximately $95,500 including engineering and contingencies, of which under present funding levels the local share would be $23,900. Annual operating costs are estimated to be $8,690.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Sterling City wish to implement a discharge plan, the following items would be required:

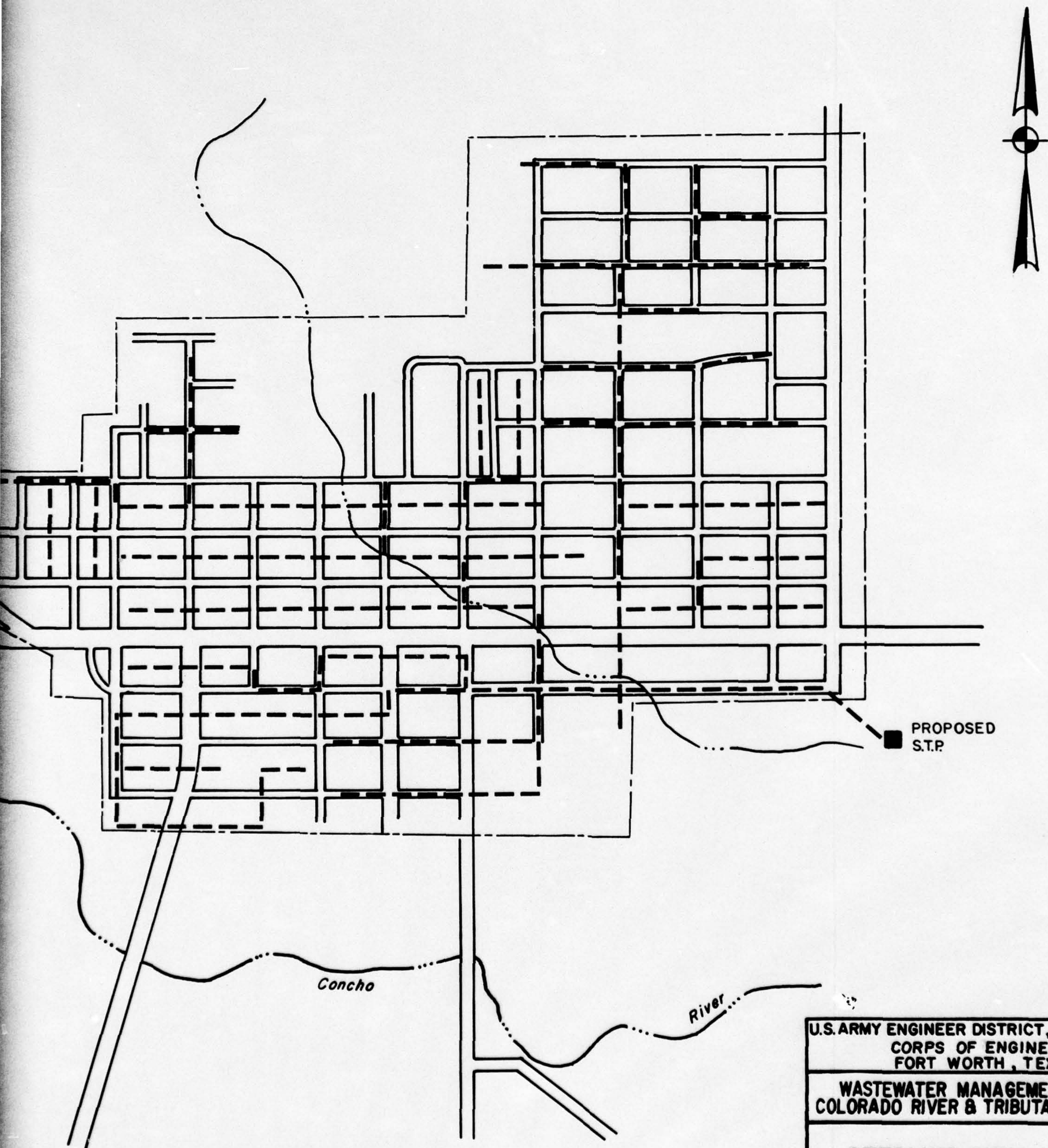
1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $95,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $87,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $81,000, including engineering and contingencies.




NOTE: LINE SIZES SET FORTH IN PREVIOUS REPORT WERE NOT AVAILABLE.




NOTE: LINE SIZES SET FORTH IN PREVIOUS REPORT WERE NOT AVAILABLE.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

STERLING CITY, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'

PLATE CV-11

## AREAWIDE PLAN
## FOR
## SANATORIUM - CARLSBAD, TEXAS
## AND
## SAN ANGELO CENTER

The Texas Department of Mental Health and Mental Retardation, San Angelo Center, formerly known as McKnight State Hospital, is located in the northwest portion of Tom Green County on U.S. Highway 87 approximately 11 miles northwest of San Angelo, Texas. Along the highway to the east of the Center are two unincorporated population concentrations referred to in various reports and on published maps as Sanatorium and/or Carlsbad. The inhabited area encompasses approximately 170 acres and lies within the jurisdiction of the Concho Valley Council of Governments. Although some disagreement exists as to the actual name or names applied to the unincorporated area, the area is composed of a well-populated area adjacent to the Center and a very sparsely populated area further to the east across the small draw shown on Plate CV-12. The area adjacent to the Center has moderate topographical relief with elevations decreasing some eight feet in a north to south direction. The eastern area has less relief but drains in the same general direction to the North Concho River.

Rowena-Mereta soils underlie the area. These types, generally 6 to 12 inches thick, have a calcareous clay loam to light clay surface over a calcareous clay that overlies either a soft or hard rock-like caliche layer. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks have severe limitations due to the strongly cemented caliche layer.

Population data developed by the TWDB for use in this study indicate that a slight increase in population is anticipated for the areas adjacent to the Center over the next fifty years. The population estimates are as follows:

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 400 | 450 | 490 | 570 |

This population projection is in addition to the Center population of approximately 500 and the Center staff of approximately 360. It is

anticipated by the Center Superintendent that over the next 2-3 years the Center population will increase to about 850 and the staff level will increase to about 480. Since a majority of the Center staff apparently reside in nearby San Angelo, it is extremely difficult to develop a firm permanent or contributory population for the area.

Land use for the area consists of the San Angelo Center grounds and light residential development, accompanied by some agriculture in the surrounding area. The economic resource base for the area is, of course, the hospital, which provides employment for most of the inhabitants and which also owns all of the available utilities. The area, accessible by Highway 87, is also served by the Colorado and Santa Fe Railroad. A slight residential growth potential is anticipated due to expansion of the hospital; however, the increase in hospital staff will probably choose to live in San Angelo to the same proportions as at present.

The municipal water supply is obtained from a ground water source consisting of two wells with 400-gpm service pumps. Storage is provided by two elevated storage reservoirs with capacities of 0.10 mg and 0.20 mg, respectively. The projected water use, exclusive of use by the Center, has been anticipated by the TWDB to be as follows:

Water Use Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.03 | 0.04 | 0.040 | 0.05 |
| Industrial Use: | None | - | - | - |

Municipal wastewater return flows from the adjacent areas have been projected by the TWQB and are as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd | 0.03 | 0.04 | 0.04 | 0.05 |
| BOD in lbs./day | 76 | 81 | 88 | 110 |
| TSS in lbs./day | 90 | 94 | 110 | 130 |

These waste load projections are, of course, in addition to the present flows from the Center, which are estimated to about 0.08 mgd by the Center Superintendent. When the Center population reaches 850, it is estimated the waste load from the Center will be about 0.125 mgd.

The existing wastewater collection and treatment system serves only the San Angelo Center. The collection system is adequate for present Center needs and serves all units on the grounds. Due to septic tank difficulties inherent with the soil types, a collection system is proposed for the more populated area adjacent to the Center as shown on Plate CV-12. It is estimated the cost of the collection system shown would be approximately $131,100, including engineering and contingencies. Under current funding levels, the local share would amount to 25 percent of the total cost, or about $32,800.

The existing sewage treatment plant serving the Center is located south of U.S. 87 as shown on Plate CV-12. The plant was constructed in 1925 with a design capacity of 0.25 mgd and presently serves all patients and employees of the hospital at an estimated loading of 0.08 mgd. The unit was completely overhauled in 1970 and has been maintained in good physical condition. The plant is of the fixed nozzle trickling filter type and consists of bar screens, grit channel, Imhoff tank, trickling filters, lift station, clarifiers, oxidation-holding ponds, and sludge drying beds. The system is laid out in parallel with only one-half currently in use. In anticipation of extra loading from a hospital expansion, plans have been made to activate the parallel unit, which would bring the plant to its full 0.25-mgd capacity. Available sampling data as published by the Texas State Department of Health are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (1970) |
|---|---|
| Raw BOD | 50 |
| Raw TSS | 30 |
| Final BOD | 12 |
| Final TSS | 10 |

Sludge disposal consists of using the dried sludge as fertilizer, and effluent from the oxidation ponds is utilized to irrigate Coastal Bermuda grass. There are no other known industrial or private waste sources in the area. In consideration of the indefinite nature of a firm contributing population estimate, it is the judgment of this study that the present facility would have adequate capacity to serve both the Center expansion and the adjacent populated area. It is therefore recommended that the proposed collection system shown on Plate CV-12 discharge to the treatment facility under an agreement between the Center, the Texas Department of Mental Health and Mental Retardation, and local residents. Utilization of the existing plant would eliminate the need for a separate facility and will effect economical usage of the capital investment in the present structure.

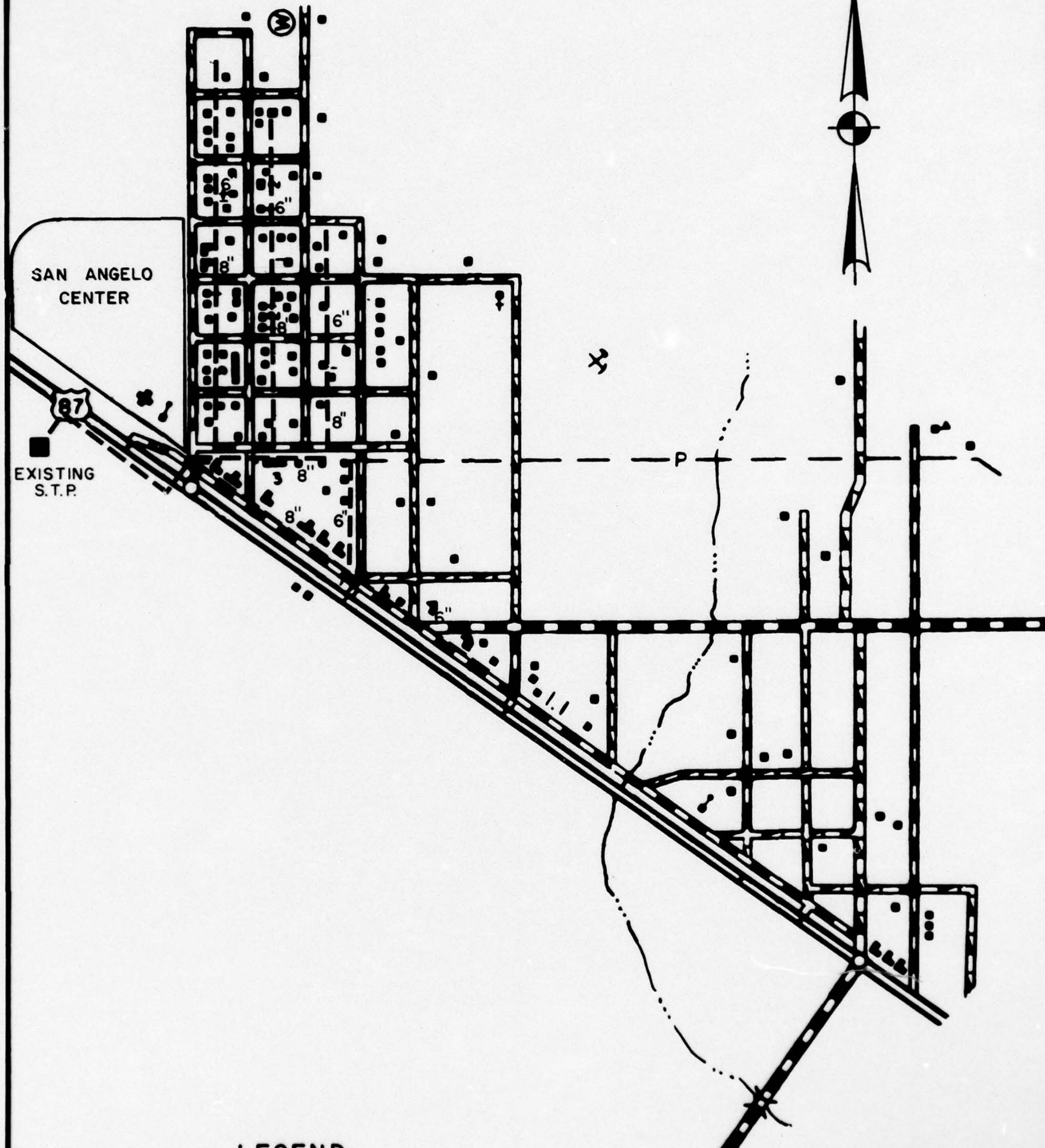
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal of effluent as practiced at the plant meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface water or ground water resources as runoff or by direct percolation. No modifications are therefore proposed for the present facility.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Sanatorium/Carlsbad wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $222,700, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $139,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $119,000, including engineering and contingencies.




LEGEND

PROPOSED SEWER LINE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SANATORIUM &
CARLSBAD, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'

PLATE: CV-12

# AREAWIDE PLAN
# FOR
# MELVIN, TEXAS

The Community of Melvin, an incorporated general law municipality, is located in the western portion of McCulloch County at the intersection of U.S. Highway 87 and F.M. 2028, approximately 60 miles east of San Angelo, Texas. The Community lies within the jurisdiction of the Concho Valley Council of Governments.

The topography in this area slopes gently to the northwest and drainage is provided by Brady Creek. The Community is primarily underlain by soils of the Frio-Uvalde Association. The Frio soils are generally found in nearly level bottomlands and consist of fairly deep, calcareous silty clays. Severe limitations are imposed on septic tanks due to a permeability of only 0.2 - 0.63 inch per hour and due to the flood hazard. The Uvalde soils occur mostly on the nearly level uplands and consist of fairly deep, calcareous silty clay loams. A permeability range of 0.63 - 2.0 inches per hour imposes only slight limitations on septic tanks.

Population data developed by the TWDB for use in this study indicate that a substantial decrease in population is anticipated for Melvin over the next fifty years. The population estimates are as follows:

<u>Population Projections</u>

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 290 | 230 | 180 | 80 |

Land use for Melvin, typical of that encountered in other small communities, is characterized by scattered residental development and a few commercial and public facilities. The economy is primarily based on agriculture, with some contribution from local oil fields and gravel mining operations. In addition to being accessible by a U.S. Highway, Melvin is served by the Atchison, Topeka and Santa Fe Railroad. Population growth is not anticipated due to the lack of any developable resource or economic activity.

The municipal water supply is obtained from one well. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

**Water Use Projections***

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.03 | 0.02 | 0.02 | 0.01 |

*Flows in mgd

Municipal wastewater return flows have been projected for Melvin by the TWQB to be as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd: | 0.03 | 0.02 | 0.01 | 0.01 |
| BOD in lb./day: | 49 | 41 | 32 | 15 |
| TSS in lb./day: | 58 | 48 | 40 | 18 |

Septic tanks are the primary means of sanitary sewage disposal in the community. A review of available maps indicates that Melvin has a light population density. Although Melvin is partially underlain by Frio soils which are classified as imposing severe limitations on septic tanks by the Soil Conservation Service, actual performance of septic tanks in the community will depend on factors such as length of the tile field, residential density, and amount of gravel placed around the drain tile. As long as no severe local problems result from utilizing septic tanks, it is recommended that their use be continued. However, should local problems occur in such severity as to require abandonment of this means of disposal, it is recommended that the septic tanks be replaced by a conventional collection and treatment system which will meet the requirements of current laws and regulations, once an absolute need for such replacement has been demonstrated.

## AREAWIDE PLAN OF CHRISTOVAL, TEXAS

Christoval is an unincorporated community located in the southern portion of Tom Green County at the intersection of U.S. Highway 277 and F.M. 2084 approximately 50 miles south of San Angelo, Texas. The Community lies within the jurisdiction of the Concho Valley Council of Governments.

The topography in this area slopes gently to the southwest and drainage is provided by the South Concho River. The Community is primarily underlain by soils of the Tarrant Stony Association. The soil consists of a shallow surface strata of cobbly clay underlain by limestone. Permeability ranges from 0.2 to 0.63 inch per hour, which imposes severe limitations on septic tanks. Severe limitations are also imposed on both septic tanks and sewage lagoons due to the shallow depth to limestone.

Population data developed by the TWDB for use in this study indicate that a slight increase in population is anticipated for Christoval over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 216 | 220 | 250 | 290 |

Land use for Christoval, typical of that encountered in other small communities, is characterized by scattered residential development and a few commercial and public facilities. In addition to being accessible by a U.S. Highway, Christoval is served by the Atchison, Topeka and Santa Fe Railroad. The economy is primarily based on agriculture, although there is some contribution from local oil fields and gravel mining operations. Population growth is not anticipated due to the lack of any developable resource and economic activity.

The municipal water supply is obtained from six wells. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.02 | 0.02 | 0.02 | 0.02 |

*Flows in mgd

Municipal wastewater return flows have been projected for Christoval by the TWQB to be as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd: | 0.02 | 0.02 | 0.02 | 0.02 |
| BOD in lb./day: | 37 | 40 | 45 | 55 |
| TSS in lb./day: | 43 | 46 | 55 | 67 |

Septic tanks are the primary means of sanitary sewage disposal in the community. A review of available maps indicates that Christoval has a light population density. Although Christoval is underlain by soils which are classified as imposing severe limitations on septic tanks by the Soil Conservation Service, actual performance of septic tanks in the community will depend on factors such as length of the tile field, residential density, and amount of gravel placed around the drain tile. As long as no severe local problems result from utilizing septic tanks, it is recommended that their use be continued. However, should local problems occur in such severity as to require abandonment of this means of disposal, it is recommended that the septic tanks be replaced by a conventional collection and treatment system which will meet the requirements of current laws and regulations, once an absolute need for such replacement has been demonstrated.

## MIDDLE RIO GRANDE DEVELOPMENT COUNCIL

### Introduction.

The purpose of this section of the report on the "Colorado River Wastewater Management Study" is to present the area-wide plan for the area within the boundaries of the Middle Rio Grande Development Council and within the Colorado River Basin. The foremost objective of the area-wide plans presented in this section is to recommend the best plan which will satisfy the requirements of PL 92-500 and the waste load allocations as set forth for the Colorado River Basin for each community presently having or in need of a municipal sewerage system.

### Planning Authority.

The planning corrdination agency for this study area is the Middle Rio Grande Development Council. The governing body is the Board of Directors. The Board is responsible for preparing and submitting an annual budget, employing an Executive Director, and establishing a Project Review Committee. The General Assembly is authorized to adopt bylaws, elect officers, adopt an annual budget, and approve applications for State and Federal assistance.

### Physical Description of Planning Area.

#### Study Area Delineation.

The Middle Rio Grande Development Council is located in southwest Texas. However, only a portion of the Council is in the Colorado River Basin. This portion includes approximately one-third of Edwards County and a minor portion of Real County, as shown on Plate MRG-A. The remainder of this discussion will deal only with this area.

#### Climatic Description.

The mean annual temperature for this area is 66°. The January minimum temperature is 38° and the July maximum is 94°. The average growing season is 250 days. The average annual precipitation is 22 inches, and the mean annual net evaporation rate is 55 inches. In the drought period that occurred from 1950 to 1956, the evaporation rate increased to 70 inches. In the summer months the prevailing winds

are from the south and southeast, while during the winter months there is no prevalent direction. The mean annual relative humidity varies from 75 percent at 6 a.m. to 43 percent to 6 p.m.

Hydrology.

The study area lies in the southern section of the Edwards Plateau where the topography is rolling and hilly, sloping gently to the southeast. The area drains to the Colorado River by way of the South Llano River, the only major tributary in the study area. There are no major lakes or reservoirs regulating the flow.

Water Resources.

The study area contains two primary aquifers, the Edwards Limestone and Trinity Sands, which underlie the entire study area. Present and projected municipal water use for the area is shown below. There is no present or projected industrial or irrigational water use in the study area.

Municipal Water Use*

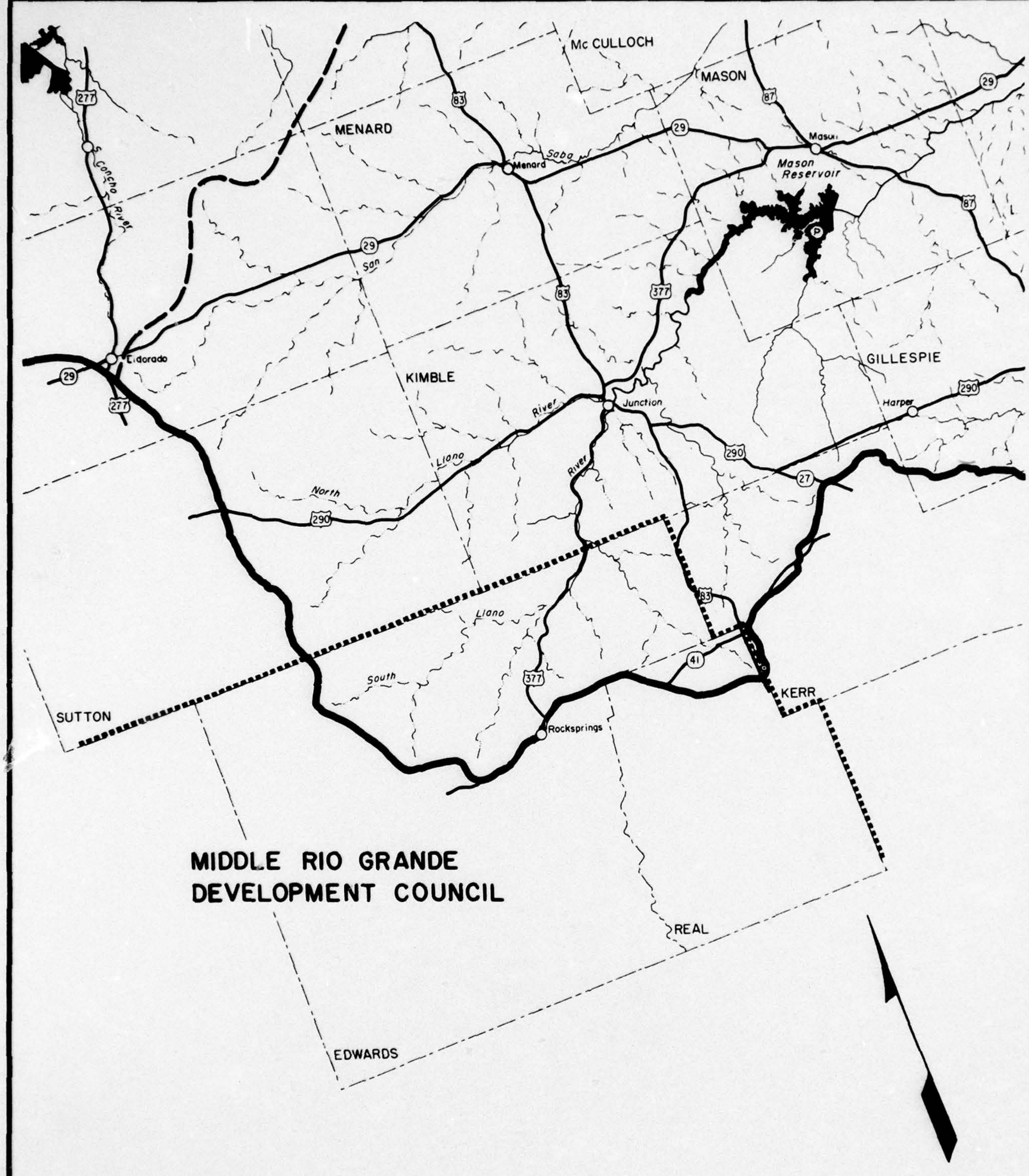
| County | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Edwards | 92 | 95 | 110 | 200 |
| Real | 8 | 9 | 10 | 7 |
| TOTAL | 100 | 100 | 120 | 100 |

*Acre-feet per year

Geology.

The surface geology of the area is mainly of the Cretaceous age. The study area lies entirely within the Edwards Plateau land resource area. The soils are generally dark calcareous stony clays with some clay loams. Natural vegetation consists of short grasses intermixed with junipers, oaks, and mesquite trees.

Social and Economic Description of Planning Area.




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MRGDC STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 16 MI. | PLATE: MRG-A

## Population.

The following table presents existing and projected population for each portion of a county within the study area. There are no urban regions within the study area to contribute to area growth.

### Population Projections

| County | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Edwards | 1,470 | 1,500 | 1,570 | 1,410 |
| Real | 95 | 90 | 90 | 70 |
| TOTAL | 1,565 | 1,590 | 1,660 | 1,480 |

## Land Use Analysis.

Most of the land in the study area is devoted to agricultural interests, primarily ranching, with vast areas of open, undeveloped land. Much of this land is used in raising Angora goats, sheep, and cattle. Only a very amount of land contains areas utilized for residential, commercial, or industrial purposes.

## Economic Analysis.

The major economic base for this area is ranching, and although the area is the center of the nation's goat-mohair production, the study area is not expected to experience significant growth in the future. Rocksprings, with a population of 1,221 in 1970, contains 78 percent of the area's people.

## Existing Waste Loads.

There are presently no wastewater treatment facilities within the jurisdiction of the Middle Rio Grande Council of Governments that lie within the boundaries of the Colorado River Basin. The only populated area that would have a possible need for a system would be the municipality of Rocksprings. An area plan for that area follows this section.

## AREAWIDE PLAN
## FOR
## ROCKSPRINGS, TEXAS

The City of Rocksprings is an incorporated municipality located in the east central portion of Edwards County at the intersection of U.S. Highway 377 and State Highway 55, approximately 110 miles south of San Angelo, Texas. The incorporated area of the City encompasses approximately 450 acres. Rocksprings is the county seat of Edwards County and is located within the jurisdiction of the Middle Rio Grande Development Council.

The City, situated on the north side of a hill, has moderate topographic relief with ground elevations decreasing about thirty feet from the south to the north. The City is underlain by Tarrant stony and Valera soil types. The Tarrant stony soil has a friable, highly calcareous, clay surface generally four to eight inches thick, over broken or partly weathered limestone or limestone bedrock at less than twelve inches below the surface. The Valera soil generally is eight to twelve inches thick with a crumbly, neutral to calcareous, clay surface over crumbly, granular, strongly calcareous clay underlain by either hard limestone bedrock coated with caliche or a bed of limestone fragments interbedded or intermixed with semi-hard caliche at depths of 10 to 36 inches beneath the surface. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks and sewage lagoons both have severe limitations due to the shallow depth of the bedrock.

Population data, developed by the TWDB for use in this study, indicate that a slight increase in population is expected for Rocksprings over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,221 | 1,300 | 1,400 | 1,300 |

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the

central areas of the City. The economic resource base is primarily ranching with most of the income derived from goat - mohair production, with no known industrial contribution.

The City, accessible by U.S. Highway 377 and State Highway 55, is not served by railroad facilities. Anticipated growth potential is slight due to the lack of adequate economic activity or resource availability.

The municipal water supply is obtained from ground water sources. The water is drawn by two wells and stored in an elevated reservoir with a 0.050 capacity. The well pumps have a total rated capacity of 850 gpm. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1972 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.07 | 0.07 | 0.09 | 0.16 |
| Industrial Use: | None | - | - | - |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flow in mgd: | 0.10 | 0.11 | 0.12 | 0.11 |
| BOD in lb./day: | 210 | 230 | 250 | 250 |
| TSS in lb./day: | 240 | 270 | 310 | 300 |

Rocksprings does not have a municipal wastewater collection and treatment system at the present time. It is believed that all residences are either on septic tanks or utilize privies. Due to the shallowness of the limestone bedrock and the limitations on septic tank drain fields, a collection and waste treatment system is proposed and shown on Plate MRG-1. The estimated cost of this proposed collection system would be $750, 300 and $157, 600 for the treatment facility. Due to the shallowness of the limestone bedrock, it is proposed that the treatment facility be of the activated sludge type, probably contact-stabilization, rather than some form of oxidation ponds.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, a contact-stabilization facility would meet all requirements of the law until 1983. At that time the City would be required to provide a higher level of treatment either by conventional tertiary facilities, which it could not afford, or by irrigation. Land disposal of effluent through irrigation meets all requirements of the law when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface water or ground water resource either as runoff or by direct percolation without adequate treatment time.

To provide an eventual high level of treatment, it is proposed that by 1983, the City either contract with local farmers to utilize the effluent as irrigation water or the City construct its own overland runoff-type of land application treatment system. A city-owned irrigation system would cost about $78, 600 for 21 acres of land, irrigation equipment and a 5.5-acre holding pond.

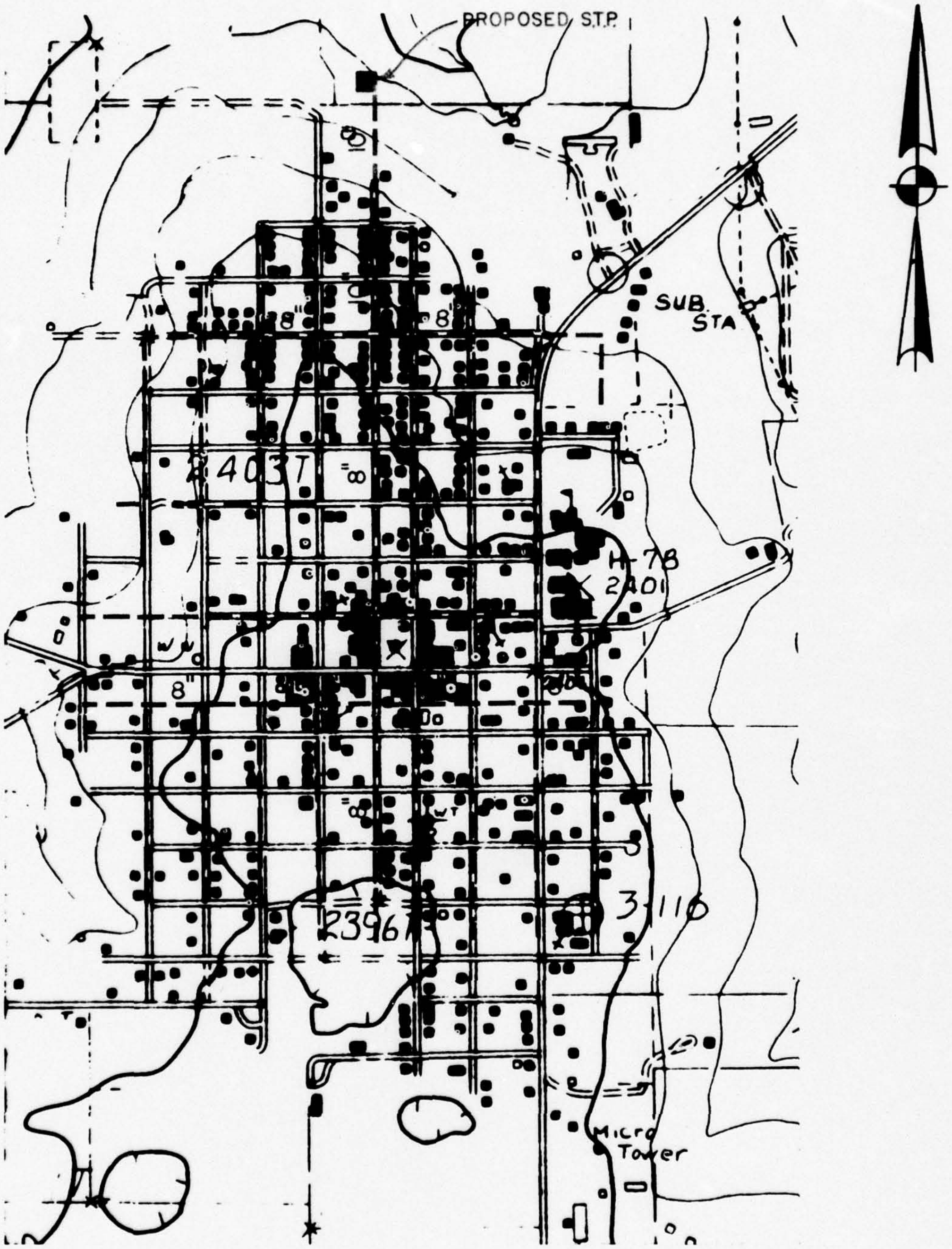
The construction of this system will allow a valuable water resource to be collected and made available to benefit the local economy. The system should also prove beneficial to the environment since it will prevent any contamination of ground water resources associated with the limestone formations and will elimimate any existing nuisances caused by inadequately operating septic tank drain fields.

It is therefore recommended that all steps necessary to implement the proposed no-discharge plan be undertaken. However, should the City of Rocksprings wish to implement a discharge plan, the following items would be required:

1. **By 1977, construct conventional secondary treatment facility at an approximate capital cost of $157,600, including engineering and contingencies.**

2. **By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $121,000, including engineering and contingencies.**

3. **By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $80,000, including engineering and contingencies.**




**LEGEND**

— — — PROPOSED SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

ROCKSPRINGS, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

| | |
|---|---|
| SCALE: 1" = 1000' | PLATE: MRG - 1 |

## Introduction.

The purpose of this section of the report on the "Colorado River Wastewater Management Study" is to present the area-wide plan for the area within the boundaries of the West Central Texas Council of Governments and within the Colorado River Basin. This section consists of an introductory sub-section giving a general physical, social, and economic description of this area, followed by a sub-section for the non-metropolitan areas, and an appendix.

The foremost objectives of the area-wide plans presented in this section are as follows:

(1) To recommend the best plan which will satisfy the requirements of PL 92-500 and the waste load allocations as set forth for the Colorado River Basin for each community presently having or in need of a municipal sewerage system.

(2) To present the three best alternative plans which will meet the highest level of treatment for the Brownwood-Early metropolitan area.

## Planning Authority.

The planning coordination agency for this study area is the West Central Texas Council of Governments, whose office is located in Abilene. The Council is composed of a Board of Directors which has the final responsibility for developing major policies and programs of the Council. The Board reviews proposed planning projects and activities of the Council, prepares necessary reports, and elects and offers recommendations to the Executive Committee. The Executive Committee is the governing body of the Council and is responsible for adopting the annual budget, expenditure of funds, hiring the Executive Director, and selecting consultants. The Council also has four Government Applications Review Committees which review applications. The Council has initiated several planning projects, two of which are a "Rural Comprehensive Water and Sewer Plan" and a "2020 Comprehensive Regional Plan for Water Quality Control and Pollution Abatement", which were both referenced during the course of this study.

There are several implementing agencies whose realm lies wholly or partly within this study area. The Central Colorado River Authority

serves the County of Coleman. The Colorado River Municipal Water District serves the portion of Scurry County which falls within the Basin, nearly all of Mitchell County, and the west central portion of Nolan County. Some other water supply and special purpose districts in this area are as follows:

Brown County WID No. 1
Coleman County WCID No. 1
Leland River FCD (Eastland and Callahan Counties)
Turkey Creek CD
Taylor County WCID No. 1
Tuscola-Taylor County FWSD No. 1
Elm Creek WCD
Runnels County WA
Valley Creek WCD
Nolan County FWSD No. 1
Several Soil and Water Conservation Districts

## Physical Description of Planning Area.

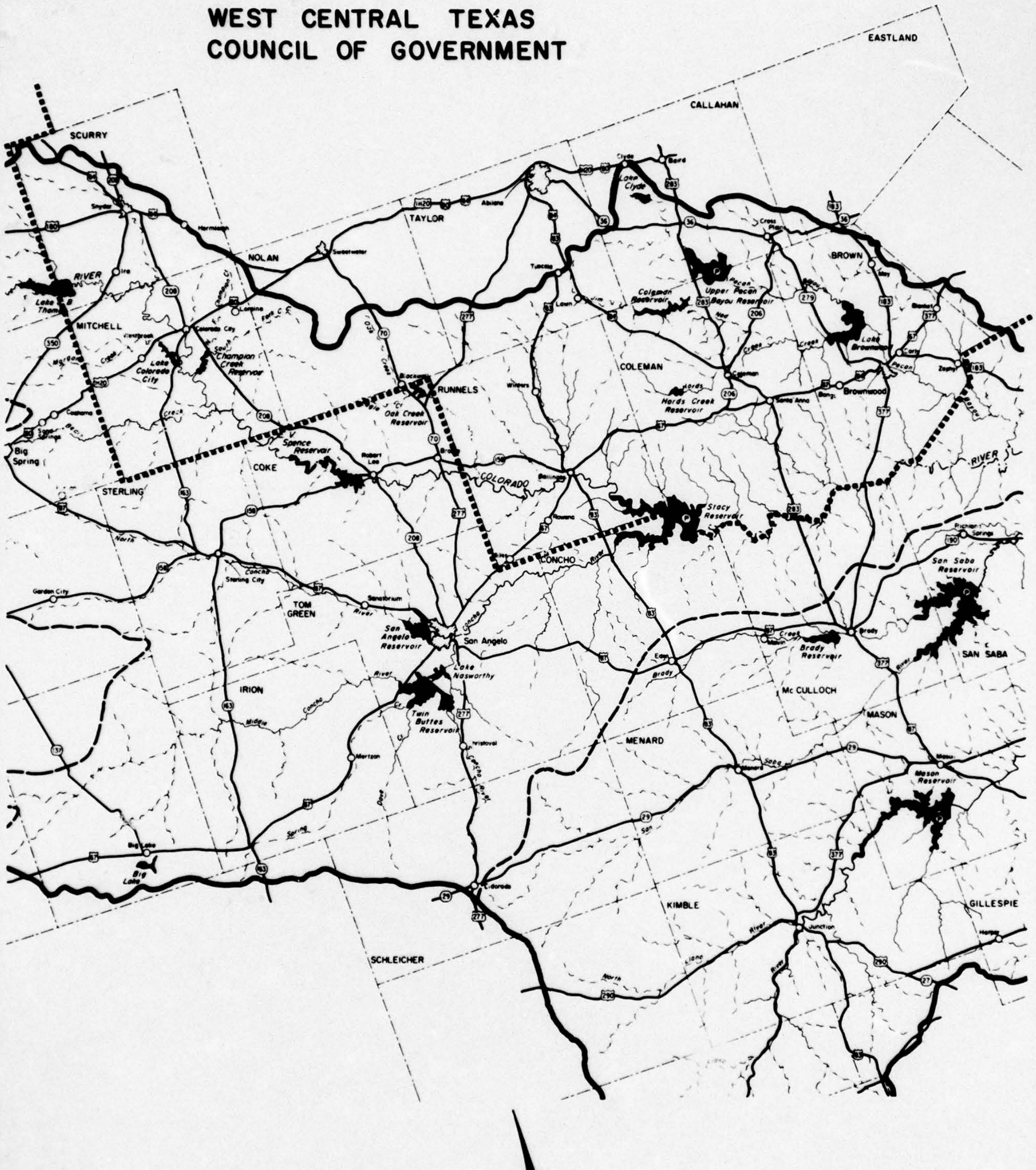
### Study Area Delineation.

This planning area is located in the west central sector of the State of Texas. The area is composed of all of Coleman, Mitchell, and Runnels Counties, nearly all of Brown County, approximately half of Scurry, Nolan, Taylor, and Callahan Counties, and only a minor portion of Eastland and Comanche Counties, as shown on Plate WCT-A.

### Climatic Description.

The average temperature data presented by Environmental Science Services Administration indicates that the mean annual temperature for the study area is 64°. The mean minimum-normal-maximum temperature variations for the study area are 30°, 44°, and 48°, respectively, for the month of January, and 70°, 83°, and 96°, respectively for the month of July. The mean length of the warm season (the period between the last winter freeze and the first fall freeze) is approximately 225 days. Although the temperature data indicate slightly cooler temperatures in the northwest sector of the study area versus the southeast sector, these minor differences will not be presented here. Thus, the temperature data given is an average for the whole study area.

# WEST CENTRAL TEXAS COUNCIL OF GOVERNMENT




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

WCTCOG STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 25 MI. | PLATE: WCT-A

The average annual rainfall varies from approximately 18 inches for the southwest sector of Mitchell County to about 28 inches for the eastern sector of Brown County. Inversely, the average net annual evaporation rate varies from about 65 inches in the southwest sector of Mitchell County to approximately 50 inches in the eastern sector of Brown County. During a drought period such as the one that occurred from 1950 to 1956, the net evaporation rates can be expected to increase 15-20 percent over normal, whereas the annual rainfall may decrease 20-25 percent below the normal annual rainfall.

During the summer months, the prevailing wind is from the south to southeast. However, during the winter months, the wind direction has no prominent prevalence. The mean annual relative humidity varies from approximately 77 percent at 6 a.m. to about 44 percent at 6 p.m.

Hydrology.

Most of the study area falls in the southern sector of the Low Rolling Plains. The topography is generally rolling and slopes gently to the southeast. The area drains to the Colorado River by way of several tributaries, of which the largest is Pecan Bayou.

Streamflow varies significantly over the study area due to the "drier" climate in the western sector versus the eastern sector. For the area above, the point where the Colorado River crosses the Mitchell-Coke County line, the flow in the Colorado River is regulated by Lake J. B. Thomas and can be expected to be below 1.3 cfs about 50 percent of the time at Colorado City. Lake Colorado City and Champion Creek Reservoirs are two other major reservoirs in this area. Tributaries to the Colorado River in this area normally have essentially zero flow for substantial lengths of time during the dry periods of the year.

For the area below the point where the Colorado River crosses the Coke-Runnels County line, the flow in the Colorado River is additionally regulated by the E. V. Spence Reservoir in Coke County. The flow can be expected to be less than 1.0 cfs about 25 percent of the time and less than 7 cfs about 50 percent of the time at Ballinger. The flow at Winchell in the southwest corner of Brown County can be expected to be less than 14 cfs about 25 percent of the time and less 56 cfs about 50 percent of the time. Three other reservoirs located in the Concho River watershed near San Angelo have some effect on the stream flow in the Colorado River below the point near the southwest corner of Coleman County

where the Concho River outfalls into the Colorado River. Future planning indicates that Stacy Reservoir will be constructed sometime in the future in the vicinity of the aforementioned point.

For the area which is drained by Pecan Bayou and its tributaries, the flow is somewhat regulated by four major reservoirs, which are Lake Brownwood, Coleman Reservoir, Hords Creek Reservoir, and Lake Clyde. The flow in Pecan Bayou at Brownwood can be expected to be zero about 7 percent of the time and to be less than 2.0 cfs approximately 50 percent of the time. The Upper Pecan Bayou Reservoir has been proposed for the future and will no doubt have additional regulatory effect on the flows of Pecan Bayou.

Water Resources.

Availability of ground water in the study area is somewhat limited and, in general, is projected to decline over the study period. There are no primary aquifers in the study area and the only secondary aquifer which has significant areal extent is the Santa Rosa aquifer. The Santa Rosa serves nearly all of Scurry County, about two-thirds of Mitchell County, and an eastern sector of Nolan County. In addition to the Santa Rosa, other minor aquifers yield small to moderate quantities of water locally. Although their potential is believed limited, they are currently supplying small quantities of water for municipal, industrial, irrigation, domestic, or livestock-watering purpose in local areas.

Surface water is the major source of water supply for the area both now and in the future. Some of the major surface water reservoirs in the area are Lake J. B. Thomas in Scurry County, Lake Colorado City and Champion Creek Reservoir in Mitchell County, Lake Clyde in Callahan County, Lake Coleman and Hords Creek Reservoir in Coleman County, and Lake Brownwood in Brown County. Many other smaller lakes provide local water supply for municipal, industrial and agricultural uses throughout the area. Two major reservoirs which have been proposed for the future are Stacy Reservoir on the Colorado River near the southwestern corner of Coleman County and Upper Pecan Bayou Reservoir near the boundary between Coleman and Callahan Counties.

Present and projected water use data were supplied by the TWDB and is summarized by counties in Tables WCT-1 and WCT-2. Only about 5 percent of the 1970 municipal water use was supplied by ground water. Ground water sources supplied 22 percent of the irrigation water in 1969, but will provide only 15 percent of the irrigation water in

2020, according to the projection. The ground water and surface water used for irrigation are projected to decline 53 percent and 22 percent respectively by 2020, with an overall decline of all water used for irrigation of 29 percent. Municipal water use is projected to decline 7.7 percent by 2020, whereas industrial water use is projected to increase 75 percent by 2020.

Another water resource which is being partially utilized at the present is the effluent from municipal water treatment plants. This resource is estimated at 5170 acre-feet per year at present, and is projected to decline to 4090 acre-feet per year in 2020. The greater portion of this resource is currently being discharged to the adjacent streams, with the other portion being disposed of through evaporation and seepage losses from oxidation ponds and by utilization for irrigation.

Geology.

The surface geology of the area consists of several geologic ages. Mitchell and Scurry Counties are principally of the Juriassic, Triassic, Pliocene, Miocene, and Oligocene ages. Brown County is mostly of the Pennsylvanian and Mississippian ages, with some area in the eastern sector being of the Cretaceous age. The remaining central portion of the study area is mostly of the Permian age, with some areas to the north being of the Cretaceous age.

Three general land resource areas exist in the study area. Nearly all of the area to the west of a north-south line bisecting Callahan County is in the Rolling Plains, with some minor areas having land resources characteristic to the Edwards Plateau. Essentially all of the area to the east of the aforementioned line are in North Central Prairies. The soils of the Rolling Plains are generally dark brown to reddish-brown, neutral to slightly calcareous sandy loams, clay loams, and clays, whereas the soils of the Edwards Plateau are dark, calcareous stony clays and some clay loams. The soils of the North Central Prairies are generally reddish-brown to grayish-brown, neutral to slightly acid sandy loams and clay loams, with some areas of stony soils. More detailed descriptions of local soils will be given for each community discussion which follows later in this section. Natural vegetation in the area to the west of the line previously described is predominantly bunch and short grasses with mesquite trees, whereas natural vegetation to the east of this same line is mostly short grasses intermixed with junipers, oaks, and mesquite trees.

## TABLE WCT-1

### MUNICIPAL AND INDUSTRIAL WATER USE
(AC-FT PER YEAR)

| | MUNICIPAL | | | | INDUSTRIAL | | | |
|---|---|---|---|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 | 1970 | 1980 | 1990 | 2020 |
| BROWN | 5,507 | 5,784 | 6,206 | 6,686 | 753 | 937 | 1,084 | 1,677 |
| CALLAHAN | 315 | 401 | 420 | 580 | 0 | 0 | 0 | 0 |
| COLEMAN | 1,751 | 1,573 | 1,315 | 751 | 6 | 7 | 8 | 12 |
| COMANCHE | 4 | 5 | 5 | 5 | 0 | 0 | 0 | 0 |
| EASTLAND | 10 | 8 | 6 | 2 | 0 | 0 | 0 | 0 |
| MITCHELL | 1,263 | 1,165 | 1,066 | 711 | 698 | 758 | 822 | 1,049 |
| NOLAN | 91 | 95 | 89 | 64 | 0 | 0 | 0 | 0 |
| RUNNELS | 1,604 | 1,605 | 1,512 | 1,188 | 20 | 22 | 24 | 29 |
| SCURRY | 2,458 | 2,518 | 2,427 | 2,028 | 724 | 817 | 887 | 1,132 |
| TAYLOR | 236 | 235 | 230 | 210 | 29 | 29 | 30 | 31 |
| TOTAL | 13,239 | 13,389 | 13,276 | 12,225 | 2,230 | 2,570 | 2,855 | 3,930 |

## TABLE WCT-2

### IRRIGATIONAL WATER USE
(AC-FT PER YEAR)

| | SURFACE WATER | | | | GROUND WATER | | | |
|---|---|---|---|---|---|---|---|---|
| | 1969 | 1980 | 1990 | 2020 | 1969 | 1980 | 1990 | 2020 |
| BROWN | 24,855 | 20,785 | 17,081 | 17,081 | 1,032 | 884 | 747 | 720 |
| CALLAHAN | 638 | 600 | 589 | 589 | 311 | 542 | 747 | 720 |
| COLEMAN | 1,407 | 1,902 | 2,356 | 2,356 | 0 | 0 | 0 | 0 |
| COMANCHE | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EASTLAND | 0 | 0 | 0 | 0 | 564 | 0 | 0 | 0 |
| MITCHELL | 60 | 0 | 0 | 0 | 2,556 | 2,570 | 2,590 | 783 |
| NOLAN | 178 | 0 | 0 | 0 | 1,467 | 695 | 0 | 0 |
| RUNNELS | 4,895 | 4,796 | 4,712 | 4,712 | 778 | 760 | 747 | 720 |
| SCURRY | 0 | 0 | 0 | 0 | 2,282 | 2,447 | 2,590 | 783 |
| TAYLOR | 438 | 515 | 589 | 589 | 420 | 590 | 747 | 720 |
| TOTAL | 32,519 | 28,598 | 25,327 | 25,327 | 9,410 | 8,488 | 8,168 | 4,446 |

## Social and Economic Description of Planning Area.

### Population.

Table WCT-3 gives the existing and projected populations for each county or portion of a county which comprises the study area, as furnished by the TWDB. The existing and projected urban population is also included in the table, in which the urban population consists of those communities with a population of 2,500 or greater. For this study area, the urban population is comprised of the populace of the Brownwood-Early metropolitan area, Snyder, Colorado City, Ballinger, Coleman, and Winters. The rural population shown in the table includes the populace of those communities with a population less than 2,500 plus the persons living on farms or in rural areas. Overall, the population in the study area is projected to decline 26.5 percent by 2020, with such decline occurring at essentially a constant rate. The urban and rural populations are projected to decline 21 and 35 percent respectively by 2020. Population projections for each city will be presented later in the individual discussions for each city. The methodology utilized by the TWDB is discussed in Appendix A of Volume II, Basin Plan Appendix.

TABLE WCT-3

Existing and Projected Population

| County | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Brown* | 25,843 | 26,470 | 27,260 | 27,760 |
| Callahan* | 2,849 | 2,920 | 2,990 | 3,020 |
| Coleman | 10,288 | 8,600 | 7,100 | 3,900 |
| Comanche* | 46 | 40 | 40 | 40 |
| Eastland* | 94 | 80 | 70 | 40 |
| Mitchell | 9,073 | 7,800 | 6,800 | 4,100 |
| Nolan* | 726 | 610 | 570 | 430 |
| Runnels | 12,108 | 10,900 | 9,800 | 6,800 |
| Scurry* | 14,684 | 13,660 | 12,680 | 9,560 |
| Taylor* | 1,946 | 1,790 | 1,720 | 1,450 |
| Total COG | 77,657 | 72,870 | 69,030 | 57,100 |
| Total Urban | 47,581 | 45,810 | 44,030 | 37,670 |
| Total Rural | 30,076 | 27,060 | 25,000 | 19,430 |

*Population for portion of county in the Colorado River Basin.

Land Use Analysis.

A recent land use inventory indicates that 96 percent of the study area is comprised of agricultural, ranching, and generally open, undeveloped land, of which approximately 31 percent is agricultural land. The remaining 4 percent of the study area is utilized for residential, commercial, industrial, public and surface water storage purposes.

Runnels County has the most prominent amount of farmland, with 51 percent of the county utilized for agricultural purposes and about 20 percent of its population living on farms. Brown County has the most land being utilized for general industrial purposes and has a general urban acreage to general industrial acreage ratio of about 5.

In general, the land use for communities in this area is typified by light to medium residential development with commercial and public facilities concentrated in the central areas of the communities and along major thoroughfares. A detailed discussion of land use for the Brownwood-Early metropolitan area will be presented later in this section.

Economic Analysis.

The economic resource base of the study area is strongly dependent upon agriculture and agricultural industries, with some minor resource available in mining and other industries. In general, the economy of the study area has failed to keep pace with the progress and changing trends of the State of Texas as a whole and the United States. One evidence of this fact is that the 1969 mean per capita income for the area was about $2,390, which is about 15 percent less than the $2,810 reported for the State of Texas.

The results of these below-average economic base conditions is further evidenced by the present and projected population trends. The rural populations are declining rapidly and are projected to continue this course. Although the Brownwood-Early metropolitan area is projected to experience some slight growth in the future, the total urban population of the area is declining and is projected to continue to decline. In other words, the area is losing its population to other areas (which are probably mostly metropolitan). Also, the migrating population is predominantly composed of the younger residents, as evidenced by the median age of the area in 1970 of 37 as compared to the median

age for the State of Texas of 26.4. The effect of youth on the economy is further evidenced by the variances within the study area. Scurry County was reported to have a 1969 per capita income of $2,603 and a median age of 32.0, whereas Coleman County had a 1969 per capita income of $2,154 and a median age of 45.5. All of the other counties in the study area have per capita incomes and median ages which fall within these values.

In summary, the study area as a whole is not expected to experience any growth in the future. On the contrary, it appears that the study area will decline economically due to the decreasing oil production in the area and the insufficient supply of other resources to support a growing population. However, some minor localized growth can be expected in a few communities which will be discussed later in this section.

Waste Loads.

The existing and projected municipal waste loads were furnished by the TWQB. The methodology utilized to determine these waste loads was to apply per capita contribution factors to the population data being utilized for this study. These per capita contribution factors are given in the following table:

Per Capita Waste Contributions

| Wastewater Characteristic | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flow (gallons per capita per day) | 85 | 85 | 85 | 85 |
| BOD (pounds per capita) | 0.17 | 0.18 | 0.18 | 0.19 |
| TSS (pounds per capita) | 0.20 | 0.21 | 0.22 | 0.23 |

The waste load data for each community with a population greater than 200 will be given later in this section. However, the municipal waste loads are summarized in three categories in Table WCT-4.

As is evident from Table WCT-4, 70 percent of the total population in the study area presently reside in communities which have municipal sewerage system, whereas only 5 percent reside in communities with a population greater than 200 which do not have a municipal sewerage system. The remaining 25 percent of the study area population mostly

## TABLE WCT-4

## Municipal Waste Load Summary

| | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| **Group 1:*** | | | | |
| Population | 54,263 | 52,160 | 50,100 | 42,940 |
| Volume (mgd) | 4.61 | 4.43 | 4.26 | 3.65 |
| BOD (ppd) | 9,200 | 9,400 | 9,000 | 8,200 |
| TSS (ppd) | 10,900 | 11,000 | 11,000 | 9,900 |
| **Group 2:**** | | | | |
| Population | 3,890 | 3,480 | 3,240 | 2,540 |
| Volume (mgd) | 0.33 | 0.30 | 0.28 | 0.22 |
| BOD (ppd) | 660 | 630 | 580 | 480 |
| TSS (ppd) | 780 | 730 | 710 | 580 |
| **Group 3:***** | | | | |
| Population | 19,504 | 17,230 | 15,690 | 11,620 |
| Volume (mgd) | 1.66 | 1.46 | 1.33 | 0.99 |
| BOD (ppd) | 3,300 | 3,100 | 2,800 | 2,210 |
| TSS (ppd) | 3,900 | 3,600 | 3,500 | 2,700 |

*Group 1 is comprised of the 12 communities which presently have municipal sewerage facilities; namely, Brownwood and Early, Ballinger, Bangs, Clyde, Coleman, Colorado City, Gross Plains, Loraine, Miles, Santa Anna, Snyder, and Winters.

**Group 2 is comprised of the 10 communities which had a 1970 population greater than 200 and do not have municipal sewerage facilities; namely, Blackwell, Blanket, Hermleigh, Ira, Lawn, May, Rowena, Tuscola, Westbrook, and Zephyr.

***Group 3 is comprised of the communities with a population less than 200, the development around Lake Brownwood, and the remaining rural population.

live on farms and ranches and have private sewage disposal systems. Naturally, the projections of municipal waste loads indicate a decline in all parameters, due to the fact that they are directly related to the population which is projected to decline.

Industrial waste produced in the area is minor in comparison with the municipal waste load. Currently, the TWQB has issued permits for the treatment and disposal of wastewater to an electric service company, a railroad switching yard, a sand and gravel company, and seven livestock feedlots. Also, the TWQB has issued seven permits to municipalities for the treatment and disposal of the water treatment plant wastes. Some industrial wastes are produced which are not under permit since they are discharged into a municipal sewer. The Brownwood sewage treatment plant appears to be receiving a significant contribution from industrial sources. The other municipal sewage treatment plants receive little or no waste contribution from industrial sources, with the only significant sources being small meat processing plants. Very little data are available concerning present and projected industrial waste loads; therefore, no data will be presented here. The little data available will be presented later in the section during the individual discussions of the communities within the study area.

Within each area plan which follows, the projected waste loadings as furnished by the TWQB are presented. These projections were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in the Basin Plan Appendix.

In an attempt to develop an estimate of the existing influent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream.

Very little of the available sampling data was consistant; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in many of the loadings and estimates presented in Table WCT-5.

# TABLE WCT-5

## EXISTING WASTE LOADS

## WEST CENTRAL TEXAS COG

| City | Estimated Population Served | Discharge | Estimated Influent Loading Flow mgd | Estimated Influent Loading BOD lb./day | Estimated Influent Loading TSS lb./day | Estimated Treatment Reduction | Estimated Effluent Loading Flow mgd | Estimated Effluent Loading BOD lb./day | Estimated Effluent Loading TSS lb./day |
|---|---|---|---|---|---|---|---|---|---|
| BROWNWOOD | 17,000 | Yes | 2.20 | 9,700 | 18,400 | 80% / 80% | 2.20 | 1,900 | 3,700 |
| BANGS | 1,400 | Yes | 0.12 | 270 | 270 | 83% / 87% | 0.12 | 45 | 35 |
| CLYDE | 2,000 | Yes | 0.17 | 200 | 230 | 71% / −15% | 0.17 | 57 | 260 |
| COLEMAN | 6,000 | No | 0.51 | 640 | 710 | 72% / 40% | 0.51 | 180 | 430 |
| CROSS PLAINS | 1,100 | Yes | 0.09 | 53 | 30 | 36% / 40% | 0.09 | 34 | 18 |
| COLORADO CITY | 6,500 | No | 0.55 | 800 | 1,300 | 80% / 80% | 0.55 | 160 | 270 |
| LORAINE | 900 | Yes | 0.08 | 93 | 130 | 65% / 77% | 0.08 | 33 | 31 |
| SANTA ANNA | 1,300 | Yes | 0.11 | 140 | 160 | 80% / 22% | 0.11 | 28 | 130 |
| BALLINGER | 4,000 | Yes | 0.34 | 770 | 500 | 72% / 40% | 0.34 | 210 | 300 |
| MILES | 500 | Yes | 0.04 | 110 | 35 | 72% / 40% | 0.04 | 30 | 21 |
| WINTERS | 4,000 | Yes | 0.34 | 850 | 1,000 | 72% / 40% | 0.34 | 240 | 630 |
| SNYDER | 12,500 | Yes | 1.06 | 1,600 | 1,500 | 80% / 80% | 1.06 | 320 | 300 |

AREAWIDE PLAN
FOR
BROWNWOOD AND EARLY, TEXAS

## Physical Description.

The City of Brownwood, a home-rule municipality located in Central Brown County, has a population of about 17,400 and an incorporated area of approximately 5,700 acres. Brownwood is situated at the junction of U.S. 183, U.S. 377, and S.H. 279 with U.S. Highway 67 at a point approximately 125 miles northwest of Austin, Texas. Brownwood is the county seat of Brown County. Adjacent to Brownwood's east side is the incorporated general-law municipality of Early. Situated on U.S. Highway 67, Early has an approximate population of 1100 people with the corporate limits emcompassing an area of approximately 1100 acres. Both Brownwood and Early lie within the jurisdiction of the West Central Texas Council of Governments.

The City of Brownwood is located on a bottomland plain west of Pecan Bayou at its confluence with Willis Creek and Adams Branch. To the west of the City is an escarpment with elevations varying from 30 to 50 feet. The rest of the City's topography has an easterly slope with elevations ranging from 1500 to 1300 feet, draining into Adams Branch and subsequently into Pecan Bayou.

Brownwood is predominantly underlain by the Frio and the Olton soils. The former, underlying the eastern part of the City, is a granular, friable and silty, clay loam from 20 to 50 inches thick overlying a granular, blocky and friable, clay loam to silty clay with a thin strata of silty loam and clayey sediments below a depth of 30 inches. Permeability rates for the Frio soil range from 0.2 to 0.6-inch per hour, imposing severe limitations on septic tanks and only slightly restricting the use of sewage lagoons.

The Olton soil, underlying the western sector of the City, has a friable loam or sandy clay loam surface 12 to 20 inches thick overlying a blocky, friable and firm, clay loam layer. Permeability in this soil ranges from 0.6 to 2.0 inches per hour for the 8-inch deep surface layer, with permeability of 0.2 to 0.6-inch per hour below the permeable surface layer. The slow internal permeability of Olton soils imposes moderate limitations on septic tanks while sewage lagoons can incur slight to moderate restrictions, depending on the side slopes of the lagoon.

Early's drainage pattern is predominantly westward into Pecan Bayou with some southerly drainage possible towards Delaware Creek in the southern portion of the community. The City of Early is underlain by Frio and Winters soils. Winters soils are generally friable, fine, sandy loam up to 14 inches thick, overlying blocky, clay loam to sand clay. This soil has a very slow (less than 0.05 in/hr.) permeability rate, thereby imposing severe restrictions on septic tanks but no limitations on sewage lagoons.

## Social and Economic Description.

### Population.

The discovery of the large oil fields and the establishment of Camp Bowie outside Brownwood prior to World War I contributed significantly to the City's dramatic initial growth. From a population of 725 in 1880, Brownwood grew to 12,789 inhabitants in 1930. World War II reinstituted Camp Bowie as a City-influencing factor, contributing to a 1950 population of 20,181. After 1950, population decreased slowly to 16,974 in 1960 and then increased only slightly to 17,368 in 1970. The population projections for the City of Brownwood furnished by the TWDB indicate that only slight growth is anticipated for Brownwood over the next fifty years, as illustrated in the following table:

**Population Projections**

| | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Brownwood | 17,368 | 17,940 | 18,430 | 18,590 |
| Early | 1,097 | 1,100 | 1,140 | 1,180 |

Presently, approximately 500 people live in an area north of Brownwood situated between Old May Road and U.S. Highway 183. Another inhabited area outside the city limits is located along U.S. 377 between Brady and Coggin Avenues. Approximately 60 dwellings are clustered in this region.

The City of Early experienced a population gain from 819 in 1960 to 1,097 in 1970. The projected population for Early, furnished by the TWDB as shown in the previous table, indicates a slight growth in population is anticipated. On a percentage basis, this growth is equivalent to the growth projected for Brownwood.

Brownwood's 1970 Census population of 17,368 has a median of 11.75 years of education, with 47.7 percent of those currently over 25 years of age having completed high school. The median family income in 1969 was $6,656 and the average family income for the same year was $8,055. The 1969 mean per capita income for Brownwood was $2,490, which is about 11 percent less than the $2,810 reported for the State of Texas. Persons of Spanish language or Spanish surname comprise 6.7 percent of the total population while Negroes comprise 5 percent.

Land Use.

An existing land-use map was compiled from an aerial photo taken in October 1971, along with the assistance of a map showing the 1958 land use for Brownwood. Projected land use was based on the slight population growth projected by the TWDB and the present growth trend of the City. Plate WCT-B-1 illustrates the existing and projected land use.

Growth of Brownwood is projected to continue primarily in the southern sector of the City as a result of the utilization of the old Camp Bowie area as an industrial park. Westward growth is limited by an escarpment and a large quarry, while eastward development is restricted by the flood plain of Pecan Bayou.

The industrial development of Brownwood is composed of a variety of agricultural and manufacturing-related plants. Further industrial development is anticipated primarily in the industrial park area in the near future by City officials. Some of the significant public facilities located in Brownwood are Howard-Payne College, a new hospital, a relatively new coliseum, a large athletic park, and two new high schools.

Economic Analysis.

Brownwood appears to have the diversified economic base necessary to sustain the present population and economy. The primary economic resource is agriculture and its related industry. Other resources consist of some manufacturing plants and the four oil fields located north and northwest of the City along with their related service industry.

Access to Brownwood and Early is provided by four major highways and by rail service provided by the Atchison, Topeka and Santa Fe Railroad. Commercial airway service at the Brownwood Municipal Airport is provided by one major carrier.

The growth potential of the Brownwood-Early metropolitan area is favorable, as evidenced by the slight population increase projected for this study. However, the rate of growth of this area will depend largely on the availability of industries seeking to locate industrial plants in west central Texas and the ability of the Brownwood metropolitan area to attract such industry.

## Water Resources and Supply.

The City of Brownwood lies about five miles west of the Trinity aquifer outcrop. The Trinity aquifer is limited in recharge potential and is highly dependent on precipitation in the area. The quality of the water drawn from wells of this aquifer is better than water drawn from other strata in the county. Although a large number of wells are drilled into this aquifer for municipal and irrigational purposes in eastern Brown County, the Brownwood area does not draw a significant amount.

The water supply source for the Brownwood area is surface water stored in Lake Brownwood, a reservoir located nine miles north of Brownwood. The Lake is owned and operated by the Brown County Water Improvement District No. 1. The safe annual yield of Lake Brownwood has been estimated by the TWDB to be 27,500 acre-feet. Water sampling records indicate that the quality of Lake Brownwood is above average when compared to other reservoirs in West Texas. Water is drawn from the Lake by 5-foot circular concrete conduits and transported via an irrigation canal for about 13-1/2 miles to a 15.0 mg holding pond. Average flow in this canal has been approximately 27 cfs over a period of 21 years, according to U.S. Geological Survey records. From this first holding pond, the water flows into an 8.0 mg pond at the Brown County WID #1 treatment plant located near U.S. Highway 377 at the southwest section of the City of Brownwood.

Treatment of the raw water consists of addition of alum, lime and chlorine, with rapid mixing and floculation in four 0.50 mg settling basins. Filtration is provided by eight 1.0 mgd rapid sand filters and one 1.5 mgd valveless filter. After treatment, the water flows to a 0.225-mg clear well and can be pumped either to distribution or to one or both 1.0 mg steel elevated ground storage reservoirs. Six pumps are available, three of which are rated at 1400 gpm, two at 3500 gpm, and one at 4,000 gpm. The total plant capacity is 9.50 mgd and the total pumping capacity is 15,200 gpm.

AT&SF RR
S.H. 279
Tom Williams Creek
Aqueduct
FM. 2125
TEMPLE AVE.
Supply
Canal
Water
Adams
OLD
COLEMAN
RD.
Branch
CITY LIMITS
WALNUT ST.
MAY
Adams
Branch
LIMITS
CITY LIMITS
OLD RAILROAD GRADE
Willis
Creek
CITY LIMITS
SLAYDEN ST.
Adams
Branch
Pecan
Bayou
U.S. 377
MORRIS
SHEPPARD DR.
CITY LIMITS
Lake
CALVERT
CREEK
RD.
INDIAN
F.M. 45
Delaware
ATCHISON TOPEKA & SANTA FE RR
F.M. 2524
F.M. 2126
F.M. 45


## LEGEND

**RESIDENTIAL / LIGHT COMMERCIAL**

- EXISTING
- 1980
- 1990
- 2020

**HEAVY COMMERCIAL / INDUSTRIAL**

- EXISTING
- 1980
- 1990
- 2020

**PUBLIC**

- EXISTING

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
*CORPS OF ENGINEERS*
FORT WORTH, TEXAS

**WASTEWATER MANAGEMENT STUDY**
**COLORADO RIVER & TRIBUTARIES, TEXAS**

# LAND USE
# BROWNWOOD - EARLY

TURNER COLLIE AND BRADEN, INC. - HOUSTON / PORT ARTHUR

SCALE: 1" = 4000' | PLATE: WCT-BE-1

The City of Early purchases raw water from the Brown County WID #1. The City's water treatment plant is located in the southeast part of the community and consists of a small clarifier coupled with three pressure filters, having a capacity of 0.6 mgd.

The projected water use for the cities of Brownwood and Early, a reflection of their respective population trends, has been furnished by the TWDB as follows:

**Brownwood Water Use Projections***

| | Year 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use | 4.02 | 4.23 | 4.40 | 4.63 |
| Industrial Use | 0.67 | 0.84 | 0.97 | 1.50 |

*Flows in mgd

**Early Water Use Projections***

| | Year 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use | 0.12 | 0.12 | 0.15 | 0.17 |

*Flows in mgd

## Waste Load Analysis.

### Municipal Waste Load.

Municipal wastewater return flows, projected for Brownwood and Early by the TWQB are as follows:

Brownwood Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd | 1.476 | 1.525 | 1.567 | 1.580 |
| BOD in lbs./day | 2,953 | 3,229 | 3,317 | 3,532 |
| TSS in lbs./day | 3,474 | 3,767 | 4,055 | 4,276 |

Early Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd | 0.093 | 0.094 | 0.097 | 0.100 |
| BOD in lbs./day | 186 | 198 | 205 | 224 |
| TSS in lbs./day | 219 | 231 | 251 | 271 |

Urban and Agricultural Runoff.

Brownwood and Early lie entirely within the drainage area of Pecan Bayou. Stormwater discharges into the stream include any urban runoff in addition to any agricultural runoff from surrounding farmland. The principal sources of pollutants in urban runoff include:

1. Street and parking lot litter, oil, and grease.
2. Animal and bird wastes deposited on impervious surfaces.
3. Fertilizers from lawns and parks.
4. Pesticides.

5. Suspended solids from excavation and construction activities and from unpaved and uplanted areas.

6. Leaves and grass.

7. Air pollutants which settle or are washed out by rain.

8. Unauthorized waste discharges into gutters, streets, storm sewers, etc.

9. Overflowing manholes in overloaded sanitary sewer systems.

Sources of agricultural runoff pollution include:

1. Inorganic fertilizers.

2. Animal and poultry wastes.

3. Insecticides and herbicides.

4. Silt and other suspended solids.

Concentrations of pollutants in runoff depend on the amounts available to be washed away by rain, time interval between rains, and the intensity and duration of rainfall. Existing studies seem to indicate that urban runoff is generally much higher in concentration of pollutants that agricultural runoff.

In semi-arid regions around Brownwood, stormwater pollution is not a significant problem due to low annual rainfall rates and a general absence of flowing streams. Rainfall is often in the form of sudden annual storms which can create more problems with flooding than with pollution from runoff.

Updated detailed information on Brownwood's drainage system was not available during the course of this study; however, all drainage from the City is to Pecan Bayou. In general, the primary means of interior drainage area open ditches and natural tributaries to Pecan Bayou, with some storm sewers being utilized in high-density commercial and residential areas.

Industrial Wastes.

Industries in the Brownwood area which could produce significant wastes are listed below along with the nature of the industry. For those industries which presently have a permit from the TWQB to dispose of waste, the respective waste control order numbers are given.

| Industry | Nature |
|---|---|
| Alpha Pork Producers, WCO #20163 | Livestock Feedlot |
| Armour Hatchery | Poultry Products |
| Atchison, Topeka and Santa Fe, WCO #00739 | Switching Yard |
| Bean's Country Sausage | Pork Sausage |
| Bean-Driskill Swine Producers, WCO #01457 | Livestock Feedlot |
| Bluebonnet Dressing Plant | Meat Processing |
| Doss, Gene Feedlot, WCO #20249 | Livestock Feedlot |
| Minnesota, Mining and Manufacturing Co. | Decorative Products |
| Phillips Products Co., Inc. | Plastic Pipe |
| Rock River Woolen Mills | Woolen Mill |
| Superior Continental Corp. | Telephone Cable |
| Swift and Company | Meat Processing and Feed Mill |
| Texas Brick Company | Brick and Tile |
| Texas Feathers | Feather Processing |
| Weller's Locker Plant | Meat Processing |
| White's Mines, Inc. | Asphaltic Concrete and Crushed Stone |
| Yeager, B.H. Feedlot, WCO #01672 | Livestock Feedlot |

Many of these industries, particularly those with waste control orders, do not discharge into Brownwood's sanitary sewer. However, as indicated by a 1971 study of the wastewater treatment plant, several industries do discharge wastes to the system, including a manufacturer of reflective material, a feather processing plant, a woolen mill, and three meat processing plants. No specific information on quantity, quality or pretreatment of these wastes was available for this study. Further discussion of the present treatment and disposal methods utilized by those industries with waste control orders is presented in the Appendix to this section.

Stormwater runoff from industrial sites can pose significant problems. Containment and treatment of runoff would vary in each

case and are probably nonexistent in some. A detailed study of each particular industrial site would be necessary to truly understand the nature and magnitude of the problem, and such is beyond the scope of this report. However, the control of runoff from livestock feedlots as prescribed in the waste control orders is discussed in the industrial waste treatment section of Appendix A. Solid wastes from these industries are generally handled onsite, utilized by local farmers for fertilizer, or are taken to the municipal landfill for disposal.

Municipal Solid Waste.

Solid waste disposal in Brownwood consists of a 4-acre sanitary landfill which is located near the site of the sewage treatment plant. Surface water flows away from the landfill and the landfill is not located in a flood prone area, therefore no pollution of surface water exists. Although no impermeable layer exists below the landfill, the landfill is underlain by a clay loam which has a low permeability, thereby limiting significantly any pollution which might result from leachate seeping into the ground water.

Water Treatment Plant Wastes.

The Brown County Water Improvement District No. 1 owns and operates the water treatment plant located in West Brownwood about one-half mile southwest of the intersection of U.S. 377 with the railroad track. The plant supplies treated water to Brownwood, Bangs and Zephyr. The wastewater from the plant, composed of backwash water, sediments and treatment chemicals, is discharged to Adams Branch, a tributary of Pecan Bayou. A field report dated March 1972 indicates that the average discharge from the plant is 150,000 gallons per day, that the effluent from the treatment plant has been of good quality, and that no apparent problems exist as a result of the discharge.

The City of Early purchases raw water from Brown Co. WID No. 1 and operates its own water treatment plant, located about 500 feet south of U.S. 67 midway between the points where it is joined by U.S. 183. Wastewater from the plant, consisting primarily of backwash water, is clarified prior to discharge to a drainage ditch which flows to Pecan Bayou. No significant problems exist from this discharge.

Waste Load Allocation.

The concept of waste load allocation is based on dividing the assimilative capacity of a particular stream among the waste contributors in such a manner that the total waste load on the stream will not exceed its ability to renew and maintain itself at the desired quality level. Pecan Bayou, which receives the discharge from the Brownwood sewage treatment plant, is an intermittent stream whose 7-day, 2-year low flow ranges from 0.1 cfs at Brownwood to 4.6 cfs at Mullin.

An analysis of the assimilative capacity of Pecan Bayou (Segment 1417), performed as a part of the Basin studies, is discussed in detail in Volume I, Basin Plan. This analysis, which used the minimum reaeration coefficients, compared the existing oxygen requirements placed on the stream with the net oxygen available in the stream after satisfying the current standard of a minimum dissolved oxygen concentration of five mg/l. The analysis utilized the most restrictive condition of low-flow, thereby providing some allowance for unknowns such as non-point sources of pollution.

There are three known waste dischargers into this segment; namely, the two Brownwood sewage treatment plants and the Atchison, Topeka and Santa Fe Railroad which has an average discharge of approximately 0.001 mgd of wash water. Only the Brownwood main sewage treatment plant was considered in the analysis since it contributes nearly 100 percent of the total carbonaceous oxygen demand contributed by the three sources. The analysis indicated that the effluent from the main plant produces slightly less than 400 pounds of biological oxygen demand per day based on an effluent $BOD_5$ of 22 mg/l. In comparison, 509 pounds of available oxygen is estimated to be present to satisfy this requirement. However, the available oxygen was determined to be deficient according to the aforementioned methodology when allowances were made for nitrogenous oxygen demand, load increases, and initial segment loading.

At present, the limiting effluent criteria for Brownwood is the TWQB requirement that effluent contain not more than 20 ppm $BOD_5$ and 20 ppm Total Suspended Solids with at least 1.0 mg/l chlorine residual after a 20-minute detention time. Therefore, an effluent which meets these criteria would not satisfy the waste load allocation imposed.

It should be pointed out that the flow in Pecan Bayou is largely composed of effluent during low-flow conditions. As evidenced by the 7-day, 2-year low base flow of 0.1 cfs in comparison with the current average discharge of 3.4 cfs, the base flow is relatively insignificant in comparison to the total flow. It is felt by the Corps of Engineers, therefore, that the prescribed calculation methodology indicates that serious oxygen depletion will occur.

Segment 1417 has been designated as the number one priority segment in the Basin. Consequently, it is possible that the effluent criteria of the current permit will not be restrictive enough to meet the dissolved oxygen requirement in the stream and it may be necessary to impose more stringent effluent criteria.

## Municipal Wastewater Collection System.

### Existing Collection System.

The existing wastewater collection system for Brownwood and Early is illustrated on Plate WCT-BE-2. The service area boundaries, major mains, outfalls and line sizes are shown. Since it was beyond the scope of this study to analyze and present all the small laterals and submains, these small sewers are not shown on the plate.

The most recent comprehensive study of the collection system, entitled "A Report with Recommendations on the Sanitary Sewer System, City of Brownwood, Texas," was published in January 1965 by Yeatts and Decker, Consulting Engineers. This report included development of design criteria, performance analysis of the existing lines, recommendation of remedial steps to correct problems, and delineation of proposed lines to meet future needs. City officials provided information to update the report to the present so that the analysis of the existing system could be used for this study. Since the study was made, the City has made corrections in most of the problem areas. At present, there seem to be no severe problems in the Brownwood sanitary sewer collection system.

As shown on Plate WCT-BE-2,the existing service area was divided into two sectors: the northern sector which serves northern Brownwood and Early, and the southern section which serves southern Brownwood. A review of the outfall sewers and major mains indicated that for the most part the lines have adequate capacity to carry the existing and future flows. Two exceptions which are marginal at present are the 12-inch main between Brady and Coggin Avenue and the 6-10-inch main just north of Willis Creek near 4th Street.

### Areas Utilizing Septic Tanks.

There are at present three areas where private septic tanks are utilized for sewage disposal. These three areas are shown on Plate WCT-B-2 as future service areas and are further located by the following descriptions:

(1) The residential area outside the city limits along U.S. 377 in the vicinity of its intersection with Brady and Coggin Avenues.

(2) The residential area east of the intersection of S.H. 279 and F.M. 2125.

(3) The residential area north of U.S. 67 along U.S. 183 and old May Road.

Soil limitations to utilizing septic tanks range from moderate to severe, depending on the nature of the soil at the specific locale. However, other factors such as the residential density, length of tile field and amount of gravel placed around the tile will also affect the performance of septic tanks in this area. Although there are no present plans for extension of sewer service to these areas, it is recommended that these areas be investigated periodically to determine whether any serious problems exist or can be anticipated as a result of utilizing septic tanks. Should such investigation indicate any such problems, it is recommended that the City extend sewer service to these areas.

Proposed Collection System.

The proposed collection system improvements for the City of Brownwood are shown on Plate WCT-BE-2. Internal reliefs are based on the sewer report mentioned previously. External expansions and proposed systems are based on land use and population projections developed for this study and were covered previously.

Since the scope of the study of the collection system was limited to analyzing existing mains and outfalls and to project only mains and outfalls as needed to serve either existing or future developed areas, the only sewer lines proposed for Brownwood are two relief sewers and three mains. The description of these sewer lines and corresponding construction costs, including engineering and contingencies, are given in Table B-1. The laterals which would be required to collect the sewage from the projected service areas and carry it to the mains were not studied and, thus are not presented herein, nor are cost estimates provided for such laterals in Table B-1.

It should be noted that these proposed improvements are for planning purposes only and are not intended to be fixed in regard to size and location. Since some of the proposed lines are intended to serve areas projected for future development, these lines will not be constructed until sufficient development is anticipated or occurs in a specific area to warrant sewer service to that area.

Table B-1

COST ESTIMATES
Proposed Sewer Lines for Brownwood, Texas

| Immediate Improvements (1975): | Estimated Cost |
|---|---|
| Relief sewer to relieve the 6"-10" main near 4th Street north of Willis Creek (2000'-10" and 2000'-2") | $ 64,000 |
| Relief sewer to relieve 12" main serving the area between Brady and Coggin Avenues (3000'-10") | 43,000 |
| Main sewer extending service to the residential area north of U.S. 67 along U.S. 183 and Old May Road (12,000'-12") | 213,000 |
| Total | $320,000 |

| Improvements Projected by 1980: | Estimated Cost |
|---|---|
| Main sewer extending service southeast to anticipated future residential development east and west of F.M. 2524 (7400'-10") | $105,000 |
| Main sewer extending service to anticipated development in the industrial park area in South Brownwood (3500'-12" and 5300'-15") | 184,000 |
| Total | $289,000 |

No sewer mains are projected for the 1990 and 2020 phase, since only very slight growth is projected for Brownwood, and this growth can be served by minor extensions of the collection system as needed.

No additional sewer mains are proposed for Early's collection system, since the small growth projected for Early will no doubt occur

in the presently lightly-developed areas and service can be extended with the existing system. As illustrated on Plate WCT-B-2, Early's collection system discharges into the Brownwood system, and the sewage is subsequently treated in the Brownwood sewage treatment plant.

## Municipal Wastewater Treatment System.

### Existing Wastewater Treatment System.

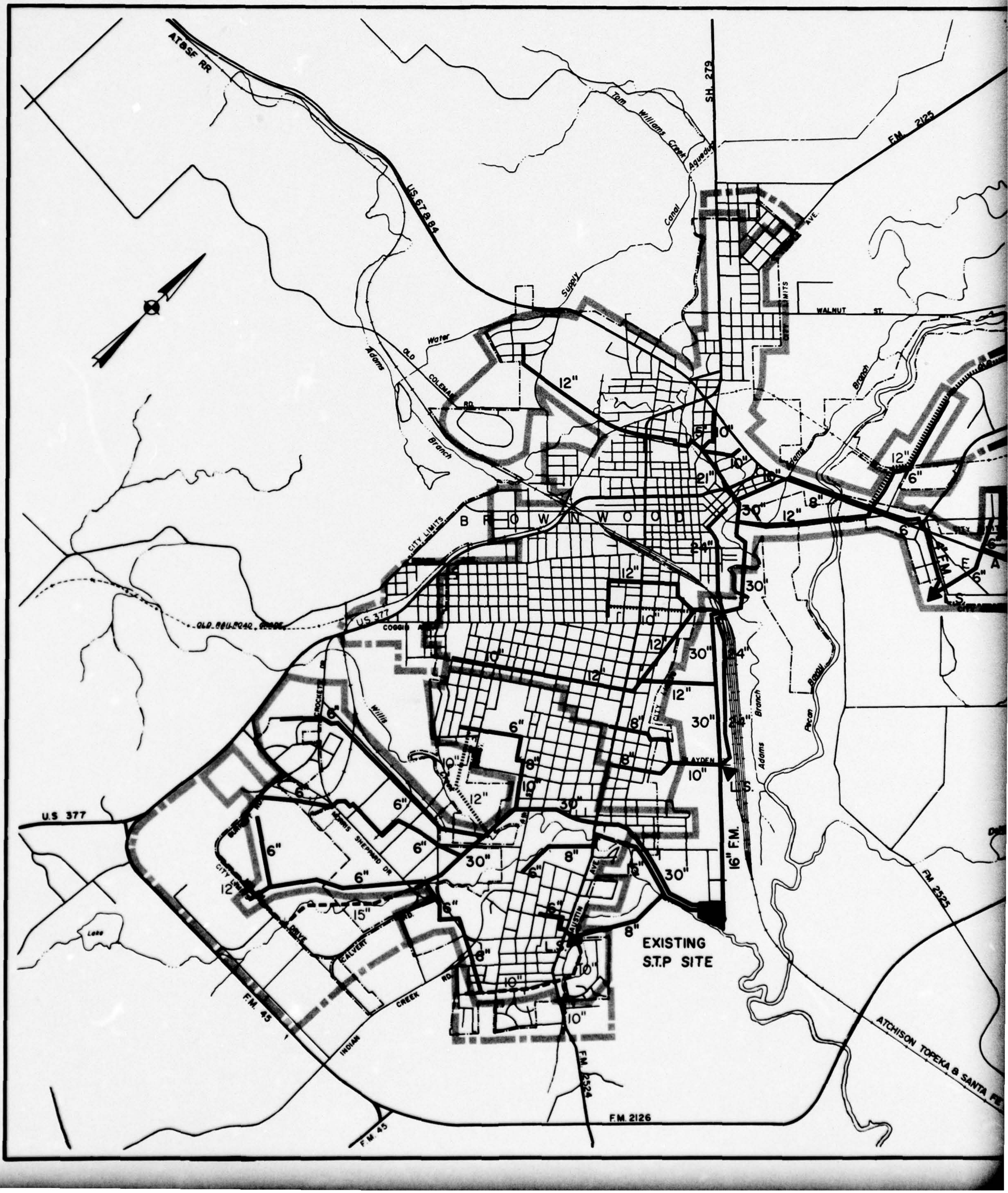
The Brownwood Sewage Treatment Plant is located just north of Willis Creek in southeast Brownwood, as shown on Plate WCT-B-2. The plant is of the trickling filter type. A detailed description of the components of the plant and the status of operation and maintenance is given in Appendix A.

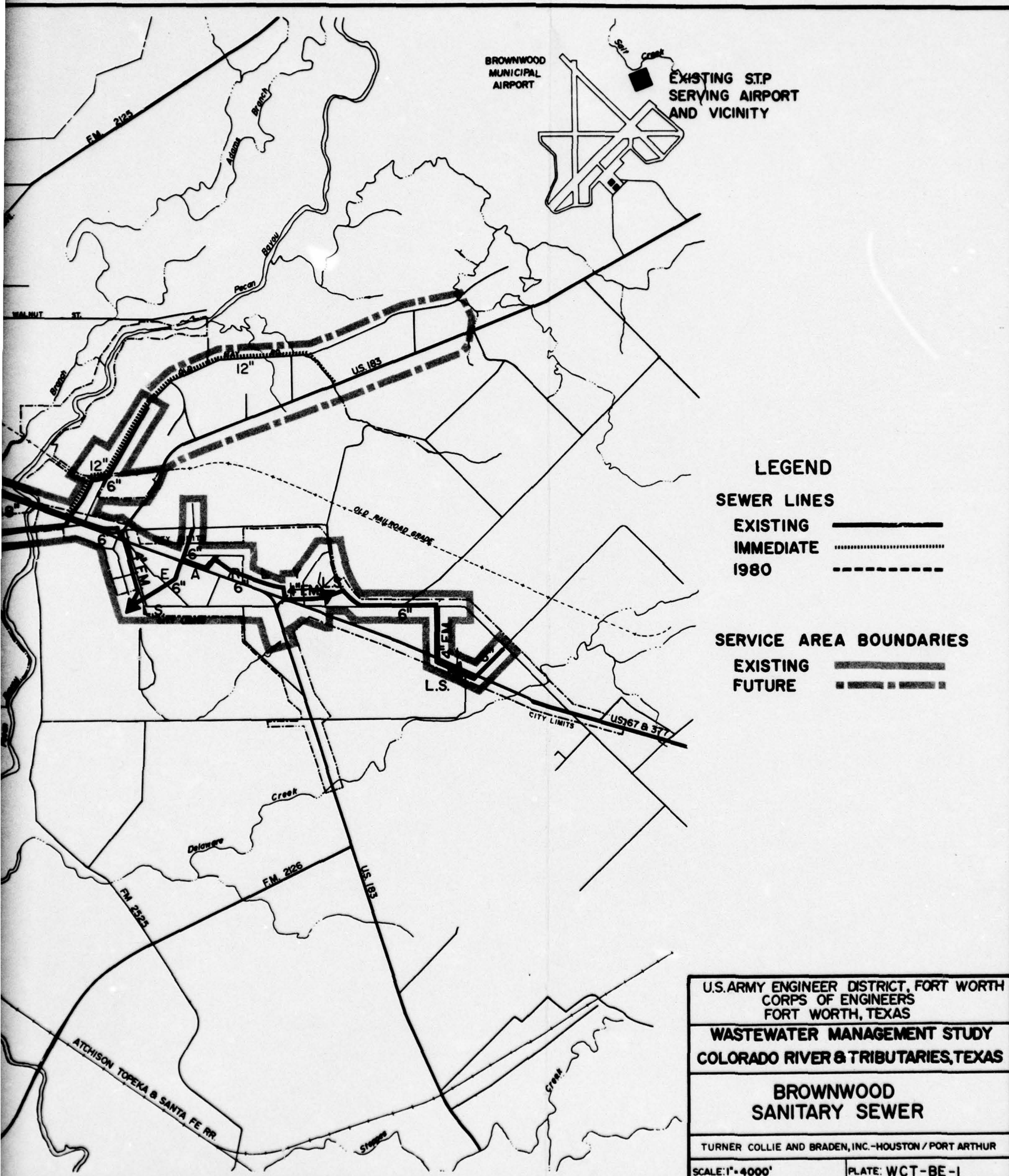
The City of Brownwood also owns and operates a small treatment facility which serves the municipal airport and vicinity. This plant is of the septic tank - trickling filter type. A detailed discussion of this plant is also presented in Appendix A.

Five permits for the treatment and disposal of industrial waste have been granted to industries in the Brownwood area. A description of these existing treatment facilities is presented in Appendix A of this section.

It should be noted that inconsistencies exist between the various sources of data concerning the present waste loading on the main sewage plant. As presented earlier, the municipal waste loads furnished for Brownwood and Early by the TWQB were based on population data utilized in this study, and indicated a 1970 average flow of 1.57 mgd. However, the treatment plant currently receives a significant amount of industrial contribution in addition to domestic wastewater. The flow presented in the TWQB projections is therefore not representative of the actual load on the plant.

As was indicated earlier, no specific data on the quantity, quality or pretreatment of industrial wastewater discharged to the sanitary sewer were available for this study. Self-reporting data supplied by the TWQB indicate the average flow to the trickling filter plant was 2.17 mgd during the period from July 1971 through June 1972. In February 1971, a study of the treatment plant was completed by Forrest


AT&SF RR
U.S. 67 & 84
SH. 279
FM. 2125
Tom Williams Creek
Aqueduct
Canal
Supply
Water
Adams
Branch
OLD COLEMAN RD.
WALNUT ST.
CITY LIMITS
B R O W N W O O D
OLD RAILROAD GRADE
U.S. 377
Willis
SHEPPARD DR
CALVERT
CREEK RD.
INDIAN
F.M. 45
F.M. 2126
F.M. 2524
F.M. 2525
Pecan Bayou
Adams Branch
L.S.
16" F.M.
EXISTING
S.T.P SITE
ATCHISON TOPEKA & SANTA FE
AUSTIN AVE.
LAYDEN
Lake
12"
10"
21"
30"
24"
8"
6"
15"



BROWNWOOD MUNICIPAL AIRPORT
EXISTING S.T.P SERVING AIRPORT AND VICINITY
Salt Creek
Adams Branch
Pecan Bayou
F.M. 2125
WALNUT ST.
US 183
12"
6"
OLD RAILROAD GRADE
L.S.
CITY LIMITS
US 67 & 377
Delaware Creek
F.M. 2126
FM 2525
ATCHISON TOPEKA & SANTA FE RR.
LEGEND
SEWER LINES
EXISTING
IMMEDIATE
1980
SERVICE AREA BOUNDARIES
EXISTING
FUTURE
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
BROWNWOOD
SANITARY SEWER
TURNER COLLIE AND BRADEN, INC.-HOUSTON / PORT ARTHUR
SCALE: 1" = 4000'
PLATE: WCT-BE-1

and Cotton, Inc., Consulting Engineers, Austin. That study reported that the estimated average flow at the plant was 2.0 mgd. However, based on further study and some flow measurements, a memorandum report published by this same firm in January 1972 indicated that the average flow to the plant was 3.03 mgd. Comparing the data, it was felt that the self-reporting data would be most representative of the average flow, since it covers a broader time period.

For the purposes of preparing alternate plans for the trickling filter plant, a design flow of 3.0 mgd was used to allow for some growth and unknown contribution. It was further assumed that the quality of the influent would be comparable to normal municipal sewage. It is recommended, however, that further investigation of the sources, quantities and qualities of industrial wastewater to the plant be made. Further detailed study should define the existing and future waste load and should be accomplished prior to formulating final designs of improvements.

Proposed Wastewater Treatment Facility Alternatives.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. Although the stream segment into which the Brownwood plant discharges is classified as a water quality segment, the analysis discussed earlier indicated that the treatment requirements set forth by the law were more crucial and therefore were utilized to develop the following plans.

The small treatment plant which presently serves the airport and vicinity discharges to Salt Creek, a tributary of Pecan Bayou. No flow data was available for this plant; however, the permitted discharge is only 5,000 gallons per day and it is felt the actual discharge is less than this value. In fact, the only reason the current treatment method has been judged acceptable is that the average daily flow through the plant is less than that required to rotate the trickling filter distribution arms.

In order to meet the requirements of the law, it is proposed that a small retention pond be built which will have a capacity to retain all effluent from the plant and eliminate discharge to Salt Creek. Disposal of the water retained in the pond should be by evaporation and irrigation of farmland. Since no actual flow rates are available, it is proposed

that the rates be determined prior to final design of improvements. The cost of such improvements cannot be determined without knowledge of the flow rates, but are anticipated to be minimal.

The effluent from the main trickling filter plant is presently discharged to Willis Creek, a tributary of Pecan Bayou. It is the present interpretation of the law that the level of discharge constituents that will be utilized to define "secondary treatment" will not be attainable by the trickling filter process currently employed by Brownwood, and the City will be required to implement a higher level of waste treatment by 1977.

Prior to presentation of the proposed wastewater treatment facility alternatives, it should be noted that proposed collection system costs are common to each alternative and these costs are therefore repeated for all alternatives.

For Brownwood, a total of twelve alternative wastewater treatment schemes were investigated during the conduct of this study. These twelve alternatives were evaluated and four alternatives were selected as the most viable alternatives. All of the twelve alternatives will meet the treatment requirements of PL 92-500. A discussion of the four most viable alternatives is presented, followed by a less detailed discussion of the eight remaining alternatives.

Further, more detailed information on treatment components, flow diagrams and anticipated treatment efficiencies is presented in Volume 3, Technical Appendix.

Alternative 1.

The most cost-effective plan, Alternative 1, to meet the requirements of the law, would be to implement a means of disposal of all effluent by 1977 whereby no discharge is made to a receiving stream. This plan proposes that the existing treatment facility should be retained in service with inclusion of any maintenance, replacement, and expansion which may be deemed necessary to operate and maintain the facility to the satisfaction of the regulatory agency. With proper modification and renovation, the plant can treat an average flow of 3.0 mgd. In addition to the current renovation of the two high-rate trickling filters which were recently out of service, it is proposed that the following improvements detailed in the aforementioned 1971 report be made by 1977:

increase the weir lengths in both the primary and final clarifiers; modify the present flow scheme such that the two high-rate filters are operated in series with the two larger standard-rate filters; renovate digesters by the addition of mixing and heating equipment; and modify existing sludge beds to conventional sludge drying beds. The cost of these improvements is estimated to be approximately $300,000, including engineering and contingencies, with an associated annual operation and maintenance cost of about $91,000.

Also, by 1977, it is proposed that land disposal of the plant effluent be utilized such that no discharge is made to a receiving stream. For the City, the most practical means of land disposal would be irrigation of crop and grassland. Irrigation could be accomplished by contracting with local farmers for the retention and irrigation of all effluent. Such a contract between the City and the landowner(s) would set forth the mutually-agreeable terms for payment of cost for constructing, operating, and maintaining the system. A cost estimate, including engineering and contingencies, for the construction of a 320-acre spray irrigation facility is given below. This facility should handle up to 3.0 mgd average flow, at a maximum average application rate of 3 inches per week and a minimum holding capacity equal to about 55 days at 3.0 mgd.

1977 Irrigation Costs

| Description | Estimated Cost |
|---|---|
| 100-Acre Holding Pond | $ 437,000 |
| Irrigation Equipment | 657,000 |
| 420-Acre Land @ $250/acre | 105,000 |
| TOTAL | $1,199,000 |

The associated annual operation and maintenance costs are estimated to be about $80,000.

Cost estimate for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 1 is presented in Appendix B of this section. Alternative 1 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 2.

Alternative 2 includes modification and expansion of the existing trickling filter plant by 1977 such that it would be converted to a 3.0-mgd activated sludge facility at an estimated cost of $860,000, including engineering and contingencies. The associated annual operation and maintenance costs for the converted facility are estimated to be $101,000. By 1983, land disposal of all effluent whereby no discharge would be made to a receiving stream would be implemented. The costs of spray irrigation would be the same as for Alternative 1, or a capital cost of $1,199,000 with associated annual operation and maintenance costs of $80,000.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 2 is presented in Appendix B of this section. Alternative 2 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 3.

Alternative 3 includes modification and expansion of the existing trickling filter plant by 1977, such that it would be converted to a 3.0-mgd activated sludge facility at an estimated cost of $860,000, including engineering and contingencies. The associated annual operation and maintenance cost would be $101,000. By 1983, partial tertiary treatment consisting of nitrification, chemical addition, and partial filtration would be added at an estimated cost of $681,000, including engineering and contingencies. The annual operation and maintenance cost of these partial tertiary treatment additions is estimated to be $194,000. To meet the goal of no discharge of pollutants, further tertiary treatment in the form of total filtration and denitrification would be added by 1985 at an estimated cost of $583,000, including engineering and contingencies. The annual operation and maintenance costs for these additions are estimated to be $79,000.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 3 is presented in Appendix B of this section. Alternative 3 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 4.

Alternative 4 includes modification and expansion of the existing trickling filter plant by 1975, such that it would be converted to a 3.0-mgd activated sludge plant capable of providing conventional secondary treatment as defined for this study. Nitrification, chemical addition, total filtration, denitrification, activated carbon treatment and aeration of the effluent are also included to provide for tertiary treatment as defined for this study. The total cost for the above improvements is estimated to be $3,623,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $471,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 4 is presented in Appendix B of this section. Alternative 4 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

The aforementioned four alternatives were selected as the most viable, cost effective alternatives. The additional eight alternatives investigated, but not selected for further refinement, are presented below. All of the following alternatives will meet the requirements of PL 92-500 and were considered assuming immediate (1975) implementation.

Alternative 5.

Alternative 5 includes modification and expansion of the existing trickling filter plant by 1975 to a 3.0-mgd trickling filter plant such that it would provide conventional secondary treatment. Tertiary treatment consisting of nitrification, chemical addition, total filtration, denitrification, activated carbon treatment and aeration of the effluent are also included. The total cost for the above improvements is estimated to be $5,390,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $400,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 5 is presented in Appendix B of this section.

Alternative 5 was not selected for further refinement because the alternative was not cost effective.

Alternative 6.

Alternative 6 includes construction of a new 3.0-mgd physical-chemical plant by 1975 to provide secondary and full tertiary treatment. The total cost for this alternative is estimated to be $2,690,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $471,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $ 6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 6 is presented in Appendix B of this section.

Alternative 6 was not selected for further refinement because (a) extensive (therefore, costly) modification of the existing process would be required; (b) this alternative was not one of the most cost-effective alternatives; (c) O&M costs are greater than for biological treatment processes; (d) large quantities of non-renewable resources (chemicals) would be required; and (e) large volumes of chemical sludges would present handling and disposal problems.

Alternative 7.

Alternative 7 includes modification and expansion of the existing trickling filter plant by 1975 such that it would be converted to a 3.0-mgd activated sludge plant capable of providing conventional secondary treatment, followed by total reuse of effluent through spray irrigation of farmland. The total costs for upgrading the plant and irrigation disposal is estimated to be $2,059,000, including engineering, contingencies and 420 acres of land at $250 per acre. Total operation and maintenance costs are estimated to be $181,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of alternative 7 is presented in Appendix B of this section.

Alternative 7 was not selected for further refinement because (a) extensive modification of the existing trickling filter process would be required; (b) the city has expressed a desire to utilize the trickling filter process, (c) this alternative was not one of the most cost-effective alternatives.

Alternative 8.

Alternative 8 includes modification and expansion of the existing trickling filter plant by 1975 to a 3.0-mgd trickling filter secondary plant followed by total filtration and total reuse of effluent through spray irrigation of farmland. The total cost for this alternative is estimated to be $1,699,000, including engineering and contingencies. The total operation and maintenance costs are estimated to be $175,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 8 is presented in Appendix B of this section.

Alternative 8 was not selected for further refinement because this alternative was not one of the most cost effective alternatives.

Alternative 9.

Alternative 9 includes construction of a new physical-chemical wastewater treatment plant by 1975 to provide conventional secondary treatment, followed by total reuse of effluent through spray irrigation of farmland. The total cost for this alternative is estimated to be $2,109,000, including engineering, contingencies, and 420 acres of land at $250 per acre. Total operation and maintenance costs are estimated to be $246,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 9 is presented in Appendix B of this section.

Alternative 9 was not selected for further refinement because (a) abandonment of the existing trickling filter process would be required; (b) the City has expressed a desire to utilize the existing trickling filter process; (c) this alternative was not one of the most cost-effective alternatives; (d) O&M costs are greater than for biological treatment processes; (e) large quantities of non-renewable resources (chemicals) would be required; and (f) large volumes of chemical sludges would present handling and disposal problems.

Alternative 10.

Alternative 10 includes modification and expansion of the existing trickling filter plant by 1975 such that it would be converted to a 3.0-mgd activated sludge plant capable of providing conventional secondary treatment, followed by the overland runoff method of land disposal. The total capital cost for this alternative is estimated to be $2,615,000, including engineering and contingencies and 580 acres of land at $250 per acre. Total operation and maintenance costs are estimated to be $206,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 10 is presented in Appendix B of this section.

Alternative 10 was not selected for further refinement because (a) extensive modification of the existing trickling filter process would be required; (b) the City has expressed a desire to utilize the existing trickling filter plant; (c) this alternative was not one of the most cost effective alternatives.

Alternative 11.

Alternative 11 includes modification and expansion of the existing trickling filter plant by 1975 to a 3.0-mgd trickling filter plant capable of providing conventional secondary treatment, followed by the overland runoff method of tertiary treatment. The total cost for this alternative is estimated to be $2,255,000, including engineering, contingencies and 580 acres of land at $250 per acre. Total operation and maintenance costs are estimated to be $200,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 11 is presented in Appendix B of this section.

Alternative 11 was not selected for further refinement because this alternative was not one of the most cost-effective alternatives.

Alternative 12.

Alternative 12 includes construction of a new 3.0-mgd physical-chemical plant by 1975 capable of providing conventional secondary treatment, followed by the overland runoff method of tertiary treatment. The total cost for this alternative is estimated to be $2,665,000, including engineering, contingencies and 580 acres of land at $250 per acre. Total operation and maintenance costs are estimated to be $271,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

| Date | Capital Cost | Annual O&M |
|---|---|---|
| 1975 | $320,000 | $6,400 |
| 1980 | 289,000 | 5,800 |

Further economic analysis of Alternative 12 is presented in Appendix B of this section.

Alternative 12 was not selected for further refinement because (a) extensive (therefore, costly) modification of the existing trickling filter process would be required; (b) the City has expressed a desire to utilize the existing trickling filter process (c) this alternative was not one of the most cost-effective alternatives; (d) O&M costs are greater than for biological treatment processes; (e) large quantities of non-renewable resources (chemicals) would be required; and (f) large volumes of chemical sludges would present handling and disposal problems.

Conclusion.

Alternative 1 was selected as the best plan for Brownwood because:

a. It meets the treatment requirements of PL 92-500.

b. It is one of the most cost-effective alternatives.

c. During public workshop, this plan was selected by participating local interests.

d. It returns wastes to the soil, thereby complying with the National goal of no discharge of critical pollutants by 1985.

Recommendation.

It is recommended that all steps necessary to implement the Alternative 1 plan be undertaken.

Continuing Responsibility.

The planning and construction of wastewater treatment facilities is only one small part of the overall treatment scheme. The application of good operation, maintenance and control techniques are essential for proper wastewater management. The most advanced equipment available is useless if it is improperly operated or poorly maintained. As an example of the optimum care required, a modern secondary treatment facility in the 2 to 4 mgd range would employ as many as one superintendent, four operators, one maintenance man and one laborer, to provide around-the-clock attendance. Land disposal facilities for Brownwood would require another 3 to 5 employees, and conventional tertiary treatment could require even more.

Every operative function in a treatment plant which involves a variable treatment mode is based on a daily sampling testing and recording program. Typical tests and frequencies include:

(1) Sludge measurements in settling tanks on each shift daily.

(2) Settleable solids volume and pH measurements daily for influent and effluent.

(3) Effluent stability tests on 24-hour composite samples.

(4) Chlorine residual of effluent on each shift daily.

(5) Total and volatile solids, volatile acids, and pH of digested sludge as needed.

(6) BOD, TSS and pH of influent and effluent daily on 24-hour composite sample.

(7) Dissolved oxygen measurement on influent, effluent and receiving stream above and below the discharge point five days per week.

(8) For activated sludge plants, DO of mixed liquor and sludge volume index on each shift daily.

In addition to providing a record of treatment efficiency, regular sampling and testing programs aid in early detection and correction of operational malfunctions in a treatment plant.

When land disposal of effluent is utilized, an additional sampling program is usually required to monitor ground water quality in the area around the disposal site. This usually consists of a series of wells surrounding the site, from which periodic samples are taken. Such monitoring is just one more means of maintaining the careful surveillance necessary to sound wastewater management.

In metropolitan areas like Brownwood, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater handling has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to the argument for responsible wastewater management, not just to meet government requirements, but also to protect the local environment. Whether it be the weekend fisherman appalled by poor surface water quality or the municipality concerned about increasing pollutant concentrations in their ground water resource, sound wastewater management is the concern and responsibility of everyone.

## APPENDIX A
## WASTEWATER TREATMENT FACILITIES
## CITY OF BROWNWOOD, TEXAS

Introduction.

During the course of study for the Colorado Wastewater Management Plan, all wastewater treatment facilities in the metropolitan areas were visited by a wastewater treatment operations specialist. The findings of the visitation report have been extracted and are summarized in the following paragraphs.

General.

The City of Brownwood at present maintains two sewage treatment plants. The main plant that serves the City and outlying areas is located on Englewood Avenue adjacent to the city garbage dump. The other plant, located off U.S. Highway 183, serves the Brownwood Municipal Airport and the immediate surrounding area. The City Department of Public Utilities has the responsibility of operation and maintenance for both plants.

The Airport sewage treatment plant has a negligible flow and is considered a "no-discharge" type operation by the TWQB. The main plant receives the waste from a population of approximately 17,000. In addition, several industries contribute to the waste load, including a meat processing plant, a woolen mill, and two small slaughter houses.

The industrial contribution is suspected to be the cause of process upsets that occur periodically. Data gathered by the City during an industrial waste monitoring program indicate that in spite of the industrial loading, the treatment plant effluent is within the quality restrictions of the TWQB. The City now plans to reactivate the high rate trickling filters in an attempt to prepare for future increases in waste load.

Description of Existing Municipal Facilities.

Municipal Airport Treatment Plant.

The sewage treatment plant which serves the Municipal Airport and immediate surrounding area has a design capacity of 0.15 mgd.

The plant was originally constructed by the U.S. Army Corps of Engineers and later given to the City of Brownwood.

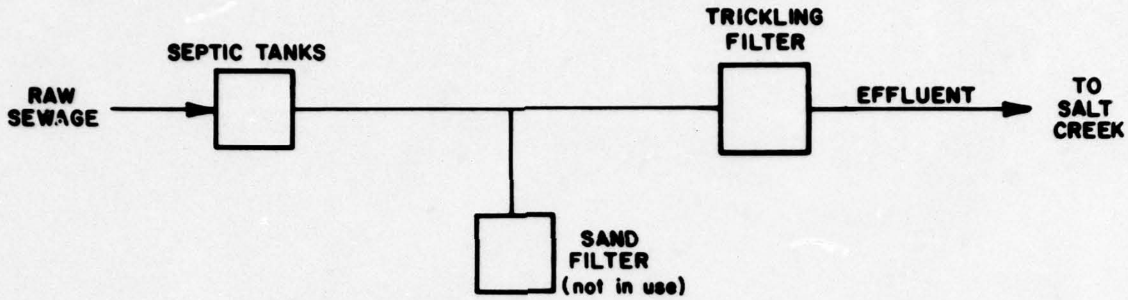
As shown schematically in Figure A-1, a 6-inch incoming sewer line feeds two parallel septic tanks. The tanks are subsurface, concrete enclosed, nonvented and have no means of solids removal. Overflow from the tanks is carried by gravity to the trickling filter distribution box via a junction box. From the distribution box, the effluent flows by gravity to the trickling filter for distribution on the rock bed. Provisions were made to flow the septic tank effluent by gravity through a sand filter prior to passing through the trickling filter. In current operation, however, the sand filter is bypassed. No provisions are available to chlorinate the filtered effluent which is presently discharged to the receiving stream without receiving further treatment.

The only reason the current procedure has been judged acceptable is that the average daily flow through the plant is not even sufficient to rotate the filter distribution arms. Storm flows, however, pass through the plant virtually untreated since no biological growth has been able to sustain itself on the rock bed. The plant receives an absolute minimum of operator coverage and maintenance. All existing units, however, appear to be in good mechanical condition.

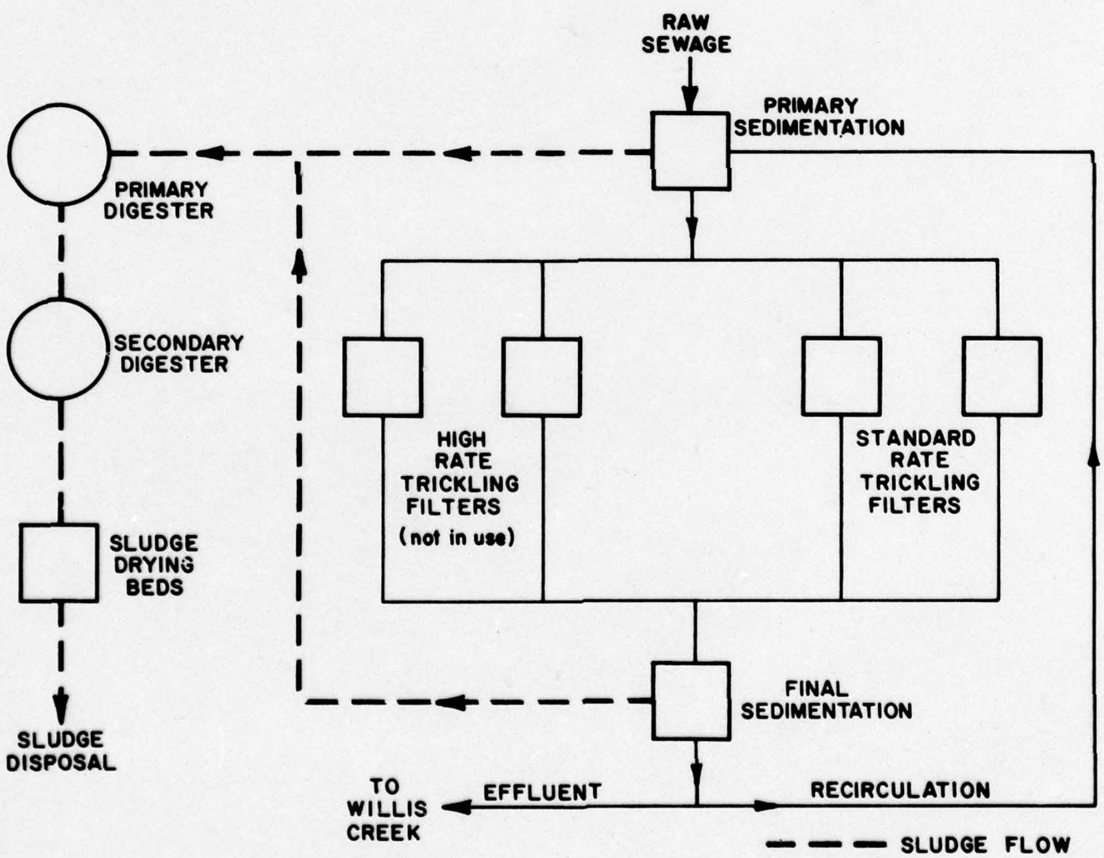
Main Sewage Treatment Plant.

The main sewage treatment plant serves an estimated population of 17,000 residing in Brownwood and its suburban areas. In addition to domestic waste, several industries discharge their waste into the system. The reported average daily wastewater flow is 3.03 mgd with a total organic loading of approximately 4000 lbs./day. Domestic wastewater contribution has been estimated to be in excess of 150 gallons per capita per day.

The waste passes through a manually-cleaned bar screen and proceeds by gravity to the rectangular primary sedimentation basin. Scum and sludge are removed by traveling rakes. The settled sewage then flows by gravity to the trickling filter distribution box and is subsequently sprayed over the rock bed of the two large, standard-rate trickling filters. The trickling filter effluent proceeds by gravity via a collection box to the final sedimentation basin which also serves as a chlorine contact tank. The plant effluent is then discharged to Willis Creek, a tributary of Pecan Bayou, which in turn is a tributary of the




FLOW DIAGRAM
BROWNWOOD MUNICIPAL AIRPORT SEWAGE TREATMENT PLANT
FIGURE A-1




FLOW DIAGRAM
BROWNWOOD MAIN SEWAGE TREATMENT PLANT
FIGURE A-2

Colorado River. Sludge from both clarifiers is pumped to the primary and secondary anaerobic digesters. A schematic flow diagram is shown in Figure A-2.

During the past several years the two small high rate trickling filters and the intermediate sedimentation basin have been out of operation. City personnel are now in the process of renovating the two filters.

All required laboratory analyses are performed by Howard Payne College in Brownwood. In spite of reported effluent qualities within permit criteria, the plant is generally in poor mechanical condition. Insufficient operator coverage and unusual operational practices, as well as poor maintenance and housekeeping, compound the problems. One of the major mechanical problems exists in the anaerobic digesters which do not function adequately because of leaks in the dome and failure of heat and mixing equipment. As a consequence, supernatant return imposes an additional load on the plant.

Physical Data, Present Facilities

| | | |
|---|---|---|
| Primary Sedimentation Tank | Number: | 1 |
| | Volume: | 59, 328 cu. ft. |
| | Surface area: | 5, 760 sq. ft. |
| | Weir length: | 130 ft. |
| Standard Rate Trickling Filters | Number: | 2 |
| | Diameter: | 150 ft. |
| | Media volume: | 3.24 acre ft. |
| High-Rate Trickling Filters | Number: | 2 |
| | Diameter: | 70 ft. |
| | Media volume: | 0.62 acre ft. |
| Final Clarifier | Number: | 1 |
| | Volume: | 40, 176 cu. ft. |
| | Surface area: | 4320 sq. ft. |
| | Weir length: | 175 ft. |

The basic units meet the Texas State Department of Health design criteria under the present waste loadings with the exception of the anaerobic digesters and the sludge beds. Based on these criteria, the existing primary sedimentation basin is adequate to treat 5.3 mgd with respect to volume, 5.2 mgd with respect to surface area, and 1.95 mgd with respect to weir length. According to the National Research Council formula, and based upon projected loadings, operation of the four trickling filter units in parallel would produce an effluent BOD of 38 mg/l. The final sedimentation basin is adequate to treat 4.8 mgd, 3.4 mgd and 2.6 mgd based upon volume, surface area and weir length, respectively. The plant site contains approximately 13 acres which could be used for expansion of current facilities.

## Capital Improvements.

The City's current plans include the expenditure of $180,000 remaining from a 1965 bond issue to reactivate the high-rate trickling filters, which will be operated in series, with about $120,000 to be spent on improving the existing equipment. Otherwise, no other expenditures are planned for wastewater treatment.

## Conclusions.

With the renovation of the two high-rate trickling filters and other essential equipment, and with a vigorous program of operation and maintenance performed by qualified and capable operators, it would seem possible to achieve some degree of successful treatment. In its present state, however, the facility must be considered in very poor condition.

## Description of Permitted Industrial Waste Treatment and Disposal Facilities.

### WCO #00739.

The Atchinson, Topeka and Santa Fe Railroad Company has a permit from the TWQB to treat and dispose of wastewater from the railroad shop area, locomotive fueling facility and switching area located in Brownwood. The wastewater consists of process water from the general maintenance of switch engines and plant facilities plus storm water runoff. A gravity type oil/water separator is in service to collect and salvage waste fuel oil which is spilled during fueling operations. Also, a substantial amount of stormwater runoff and some ground water

seepage is directed to the separator. The effluent from the separator is discharged to a tributary of Pecan Bayou, under the regulations of waste control order No. 00739. Since no further information is available which would indicate that the present treatment facility is inadequate, no future improvements are herein recommended unless such are deemed necessary in the future.

WCO #01457.

Bean-Driskil Swine Producers own and operate a 1000-head swine feedlot located 0.7 miles east of the intersection of F.M. 2125 with S.H. 279 just outside the city limits of Brownwood. The wastewater and runoff from the production area is retained in a holding pond with a capacity of 5.2 acre-feet and disposed by evaporation and sprinkler irrigation of 50 acres of pasture land. No discharge is permitted except in the event of rainfall exceeding 8.0 inches in any 24-hour period, when the area would drain to Pecan Bayou. Solid wastes are disposed on the land as a soil amendment and fertilizer.

WCO #01672.

B. H. Yeager feedlot is a 1,000-head cattle feedlot located approximately 2.5 miles north-northeast of the intersection of U.S. 183 North with U.S. 67. The runoff from the feeding pens is retained in a holding pond with a capacity of 22 acre-feet and is disposed of by evaporation and by irrigating about 7 acres of grassland. No discharge is permitted except during rainfall greater than 7 inches in a 24-hour period when a discharge may be made to a tributary of Pecan Bayou. However, such a discharge is quite unlikely since the present retention pond has more than twice the capacity needed to retain all of the runoff from this rainfall. Solid wastes which accumulate at this feedlot are distributed to area farmers for use as a soil amendment and fertilizer.

WCO #20163.

Alpha Pork Producers owns and operates a 1,730-head commercial swine production facility located just east of F.M. 590 at a point 5 miles northeast of Zephyr, which is approximately 14 miles east of Brownwood. The wastewater consists of liquid waste and wash water from swine farrowing and finishing operations.

The waste control facilities include two completely enclosed farrowing houses and two completely enclosed nurseries, underfloor

lagoons, plastic drain tiles, two retention ponds with a total capacity of 0.4 acre-foot, and diking to divert offsite runoff around the facility. Liquid waste collected in the retention ponds will be disposed of by evaporation and irrigation of 50 acres of pastureland, with no discharge to a stream. The operation is located with the drainage area of Big Blanket Creek, which is a tributary to Pecan Bayou. Solid waste is spread on 15 acres of farmland when disposal becomes necessary.

WCO #20249.

The Gene Doss feedlot is a 600-head commercial swine production facility located approximately 2 miles southeast of the intersection of F.M. 586 with U.S. 377, which is about 14 miles southwest of Brownwood. The wastewater consists of liquid waste and wash water from covered farrowing and finishing houses and some surface runoff from the facility. The wastewater is retained in a holding pond with a capacity of about 0.61 acre-foot and is disposed of by evaporation and by irrigation of 30 acres of grassland and cropland. No discharge to an adjacent stream is permitted. However, if a discharge should occur during extreme rainfall conditions, the discharge would be to a tributary of Clear Creek. Solid wastes are spread on about 30 acres of grassland and cropland.

## APPENDIX B

### Economic Analysis of Alternatives

Each of the wastewater treatment facility alternatives for Brownwood was subjected to an economic analysis. The results of these analyses, by alternative, are presented as computer printouts following the cost summary. The first four column entries are input data and include a description of the item under consideration, the date by which an item is to be constructed or operational, the capital cost of each item and the annual operation and maintenance cost of each item. The next three column entries are calculated values of Capital Cost Present Worth, O&M Present Worth, and Total Present Worth, all of which were calculated at 5.5 percent interest. These values were also calculated for 7.0 percent and 10.0 percent interest, with results appearing under line entries INT RT = 0.07 and INT RT = 0.10 respectively. All values shown are in January 1972 dollars.

BROWNWOOD, TEXAS

Cost Summary

| Alternative | Total Present Worth* | | |
|---|---|---|---|
| | 5.5% | 7.0% | 10% |
| 1 | $ 4,068,532 | $3,426,341 | $2,581,812 |
| 2 | 3,895,340 | 3,199,505 | 2,292,229 |
| 3 | 5,496,268 | 4,330,209 | 2,888,052 |
| 4 | 10,334,517 | 8,833,946 | 6,661,284 |
| 5 | 10,838,767 | 9,387,807 | 7,462,742 |
| 6 | 9,539,961 | 7,972,340 | 5,960,307 |
| 7 | 4,915,835 | 4,236,471 | 3,337,306 |
| 8 | 4,524,700 | 3,875,966 | 3,022,372 |
| 9 | 5,874,413 | 4,999,186 | 3,856,526 |
| 10 | 5,741,639 | 4,967,986 | 3,940,289 |
| 11 | 5,350,504 | 4,607,482 | 3,625,355 |
| 12 | 6,700,217 | 5,730,701 | 4,459,509 |

*Total Present Worth = Capital Cost Present Worth plus O&M Present Worth.

## Brownwood Alternatives

### Cost Comparison

#### ALTERNATIVE 1

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| UPGRADE EXIST | 1975 | 300000. | 91000. | 255484. | 1282397. | 1537881. |
| SPRAY IRRIG | 1977 | 1199000. | 80000. | 917396. | 1001593. | 1918990. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 2108000. | 8055000. | 1633709. | 2434823. | 4068532. |
| INT RT=.070000 | | 2108000. | 8055000. | 1529176. | 1897165. | 3426341. |
| INT RT=.100000 | | 2108000. | 8055000. | 1345120. | 1236692. | 2581812. |

#### ALTERNATIVE 2

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS SECONDARY | 1977 | 860000. | 101000. | 658016. | 1264512. | 1922527. |
| SPRAY IRRIG | 1983 | 1199000. | 80000. | 665338. | 695813. | 1361151. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 2668000. | 7823000. | 1784182. | 2111158. | 3895340. |
| INT RT=.070000 | | 2668000. | 7823000. | 1612220. | 1587285. | 3199505. |
| INT RT=.100000 | | 2668000. | 7823000. | 1329476. | 962753. | 2292229. |

#### ALTERNATIVE 3

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| AS SECONDARY | 1977 | 860000. | 101000. | 658016. | 1264512. | 1922527. |
| PARTIAL TERT | 1983 | 681000. | 194000. | 377894. | 1687347. | 2065241. |
| TERTIARY | 1985 | 583000. | 79000. | 290661. | 606177. | 896838. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 2733000. | 14806000. | 1787399. | 3708869. | 5496268. |
| INT RT=.070000 | | 2733000. | 14806000. | 1608047. | 2722163. | 4330209. |
| INT RT=.100000 | | 2733000. | 14806000. | 1316794. | 1571258. | 2888052. |

## Brownwood Alternatives

### Cost Comparison (Cont'd)

ALTERNATIVE 4

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS TERTIARY | 1975 | 3623000. | 471000. | 3085396. | 6637459. | 9722855. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| CULLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 4232000. | 21715000. | 3546225. | 6788292. | 10334517. |
| INT RT=.070000 | | 4232000. | 21715000. | 3386863. | 5347083. | 8733946. |
| INT RT=.100000 | | 4232000. | 21715000. | 3097255. | 3564029. | 6661284. |

ALTERNATIVE 5

| ITEM | DATE | CAPITAL COST | U-M COST | CAP CUST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| TF TERTIARY | 1975 | 5390000. | 400000. | 4590198. | 5636908. | 10227105. |
| COLLECTIUN SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| CULLECTION .SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 5999000. | 18520000. | 5051026. | 5787741. | 10838767. |
| INT RT=.070000 | | 5999000. | 18520000. | 4829262. | 4558546. | 9387807. |
| INT RT=.100000 | | 5999000. | 18520000. | 4424828. | 3037913. | 7462742. |

ALTERNATIVE 6

| ITEM | DATE | CAPITAL COST | O-M COST | CAP CUST PRES WORTH | U-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| PC TERTIARY | 1975 | 2690000. | 471000. | 2290841. | 6637459. | 8928300. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 3299000. | 21715000. | 2751669. | 6788292. | 9539961. |
| INT RT=.070000 | | 3299000. | 21715000. | 2625257. | 5347083. | 7972340. |
| INT RT=.100000 | | 3299000. | 21715000. | 2396278. | 3564029. | 5960307. |

## Brownwood Alternatives

### Cost Comparison (Cont'd)

ALTERNATIVE 7

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS-SP IRRIG | 1975 | 2059000. | 181000. | 1753473. | 2550701. | 4304173. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 2668000. | 8665000. | 2214301. | 2701534. | 4915835. |
| INT RT=.070000 | | 2668000. | 8665000. | 2110173. | 2126297. | 4236471. |
| INT RT=.100000 | | 2668000. | 8665000. | 1922199. | 1415107. | 3337306. |

ALTERNATIVE 8

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| TF-SP IRRIG | 1975 | 1699000. | 175000. | 1446892. | 2466147. | 3913039. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 2308000. | 8395000. | 1907720. | 2616980. | 4524700. |
| INT RT=.070000 | | 2308000. | 8395000. | 1816306. | 2059660. | 3875966. |
| INT RT=.100000 | | 2308000. | 8395000. | 1651725. | 1370647. | 3022372. |

ALTERNATIVE 9

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| PC-SP IRRIG | 1975 | 2109000. | 246000. | 1796053. | 3466698. | 5262751. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTION SYS | 1980 | 289000. | 5800. | 188312. | 60643. | 248955. |
| INT RT=.055000 | | 2718000. | 11590000. | 2256882. | 3617531. | 5874413. |
| INT RT=.070000 | | 2718000. | 11590000. | 2150908. | 2848198. | 4999106. |
| INT RT=.100000 | | 2718000. | 11590000. | 1959764. | 1896762. | 3856526. |

## Brownwood Alternatives

### Cost Comparison (Cont'd)

ALTERNATIVE 10

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| AS-OR IRRIG | 1975 | 2615000. | 206000. | 2226970. | 2903007. | 5129977. |
| COLLECTION SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| CULLECTION SYS | 1900 | 289000. | 5000. | 180312. | 60643. | 240955. |
| INT RT=.055000 | | 3224000. | 9790000. | 2687790. | 3053841. | 5741639. |
| INT RT=.070000 | | 3224000. | 9790000. | 2564035. | 2403951. | 4967986. |
| INT RT=.100000 | | 3224000. | 9790000. | 2339930. | 1600359. | 3940289. |

ALTERNATIVE 11

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PRES WORTH |
|---|---|---|---|---|---|---|
| TF-OR IRRIG | 1975 | 2255000. | 200000. | 1920389. | 2810454. | 4730843. |
| COLLECTIUN SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| CULLECTION SYS | 1900 | 289000. | 5000. | 180312. | 60643. | 240955. |
| INT RT=.055000 | | 2864000. | 9520000. | 2381217. | 2969287. | 5350504. |
| INT RT=.070000 | | 2864000. | 9520000. | 2270168. | 2337314. | 4607482. |
| INT RT=.100000 | | 2864000. | 9520000. | 2069456. | 1555899. | 3625355. |

ALTERNATIVE 12

| ITEM | DATE | CAPITAL COST | O-M COST | CAP COST PRES WORTH | O-M PRES WORTH | TOTAL PREC WORTH |
|---|---|---|---|---|---|---|
| PC-OR IRRIG | 1975 | 2665000. | 271000. | 2269550. | 3819005. | 6088555. |
| COLLECTIUN SYS | 1975 | 320000. | 6400. | 272516. | 90191. | 362707. |
| COLLECTIUN SYS | 1900 | 289000. | 5000. | 180312. | 60643. | 240955. |
| INT RT=.055000 | | 3274000. | 12715000. | 2730379. | 3969838. | 6700217. |
| INT HT=.070000 | | 3274000. | 12715000. | 2604850. | 3125852. | 5730701. |
| INT RT=.100000 | | 3274000. | 12715000. | 2377495. | 2082014. | 4459509. |

# APPENDIX C

## Evaluation Analysis of Alternatives

Appendix C presents an evaluation of the four most viable alternatives with respect to environmental, social, economic, technological, and resource conservation considerations. In order to maintain the time schedule allotted for the study, the investigations of the foregoing features were conducted in a general manner with emphasis on their relation to the overall system evaluation. While detailed studies were not made on the specific features, these items were investigated to a degree that would uphold the integrity of the validity of the alternative evaluation process. The current status of the existing wastewater treatment facility was used as the base condition from which the evaluations were made.

## BROWNWOOD

### Evaluation Analysis

| | ALTERNATIVE 1: Renovate trickling filter by 1975. Facility modifications plus irrigation by 1977. | ALTERNATIVE 2: Modify existing trickling filter system to activated sludge process and expand by 1977. Irrigation of all effluent by 1983. | ALTERNATIVE 3: Modify existing trickling filter system to activated sludge process and expand by 1977. Partial tertiary treatment by 1983. Complete tertiary treatment by 1985. | ALTERNATIVE 4: Modify existing trickling filter system to complete tertiary treatment utilizing activated sludge process by 1975. |
|---|---|---|---|---|
| A. Environmental Quality | | | | |
| 1. Water Resource | | | | |
| a. Effluent Quality | Removal of BOD and SS would approach 100% and would be higher than attainable by overland runoff. High removal of nutrients. Best removal of phosphorus. | Removal of BOD and SS would approach 100% and would be higher than attainable by overland runoff. High removal of nutrients. Best removal of phosphorus. | Removal of BOD/SS would approach 98%. Better removal of phosphorus than overland runoff. | Removal of BOD/SS would approach 98%. Better removal of phosphorus than overland runoff. |
| b. Groundwater | Positive potential for recharge. No detrimental effect due to high quality water. | Positive potential for recharge. No detrimental effect due to high quality water. | Positive potential for recharge. For this alternative, probably will not be used for recharge. | Positive potential for recharge. For this alternative, probably will not be used for recharge. |
| c. Streamflow | No change from existing. No flow to streams other than small flow from percolation. | No change from existing. No flow to streams other than small flow from percolation. | Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry. | Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry. |
| 2. Air Resource | | | | |
| a. Odors | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. | Slight potential for odors. Decrease from existing odors as a result of utilizing aerobic systems. |
| b. Other Sources | Aerosol potential slight. | Aerosol potential slight. | Carbon regeneration could cause problems. | Carbon regeneration could cause problems. |
| 3. Land Resource | | | | |
| a. Land Quality | Increase productivity. | Increase productivity. | Land released for other uses. | Land released for other uses. |
| b. Land Utilization | Large area requirement. Committed for long period of time (420 acres). | Large area requirement. Committed for long period of time (420 acres). | Small land requirements. (About 5 acres.) | Small land requirements. (About 5 acres.) |

## BROWNWOOD

### Evaluation Analysis (Cont'd.)

| | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 | ALTERNATIVE 4 |
|---|---|---|---|---|
| A. Environmental Quality (Cont'd.) | | | | |
| 4. Biological | | | | |
| a. Zoological | Would change wildlife habitat characteristics. Probably increase species diversity and total number. | Would change wildlife habitat characteristics. Probably increase species diversity and total number. | Small land commitment for construction of physical facilities will produce negligible effect. | Small land commitment for construction of physical facilities will produce negligible effect. |
| b. Botanical | Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing. | Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing. | Small land commitment for construction of physical facilities will produce negligible effect. | Small land commitment for construction of physical facilities will produce negligible effect. |
| 5. Geological | If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge. | If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge. | Small land commitment for construction of physical facilities will produce negligible effect. | Small land commitment for construction of physical facilities will produce negligible effect. |
| B. Social | | | | |
| 1. Manpower | Additional personnel required. Non-technical for land disposal system available locally. | Additional personnel required. Non-technical for land disposal system available locally. | Additional personnel required. Highly skilled technical personnel may not be available locally. | Additional personnel required. Highly skilled technical personnel may not be available locally. |
| 2. Aesthetics | Land disposal site could be used to influence direction of growth—utilized as green belt. | Land disposal site could be used to influence direction of growth—utilized as green belt. | No anticipated problems. | No anticipated problems. |
| 3. Political Acceptability | System presently utilized by surrounding municipalities. Possible objections to increase of city owned land if leasing is no^ available. | System presently utilized by surrounding municipalities. Possible objections to increase of city owned land if leasing is not available. | May not be acceptable due to requirement for highly skilled labor and substantial capital cost. | May not be acceptable due to requirement for highly skilled labor and substantial capital cost. |
| C. Economic | Possible agricultural revenue. Additional employment required. (Regional effect.) | Possible agricultural revenue. Additional employment required. (Regional effect.) | Larger revenue potential because of higher economic use of water. Increase in skilled employment. However, high associated costs may not be acceptable. | Larger revenue potential because of higher economic use of water. Increase in skilled employment. However, high associated costs may not be acceptable. |

## BROWNWOOD

### Evaluation Analysis (Cont'd.)

| | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 | ALTERNATIVE 4 |
|---|---|---|---|---|
| D. Technology<br>1. Reliability/ Flexibility | More reliable. Effluent quality not as susceptible to load variations or influent quality. | More reliable. Effluent quality not as susceptible to load variations or influent quality. | More flexible. Effluent available directly for many uses. | More flexible. Effluent available directly for many uses. |
| 2. Construction Effects | Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible. | Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible. | Less detrimental because of smaller land requirements. | Less detrimental because of smaller land requirements. |
| E. Institutional Arrangements | No change if city operates land disposal systems. Difficulties could be encountered if city contracts with farmer(s) for operation of irrigation systems. | No change if city operates land disposal systems. Difficulties could be encountered if city contracts with farmer(s) for operation of irrigation systems. | Change could be required to restructure functions and responsibilities of public works departments. | Change could be required to restructure functions and responsibilities of public works departments. |
| F. Resource Conservation | Large land areas would be committed for many years. | Large land areas would be committed for many years. | Chemical requirements would commit large quantities of non-renewable resources. | Chemical requirements would commit large quantities of non-renewable resources. |

AREAWIDE PLAN
FOR
BANGS, TEXAS

The City of Bangs is an incorporated, general law municipality located in west central Brown County on U.S. Highway 67 approximately 9 miles west of Brownwood, Texas. The incorporated area of the City encompasses approximately 600 acres. Bangs is within the jurisdiction of the West Central Texas Council of Governments.

The City has little topographical relief, with a maximum elevation variation of 20 feet. Bangs drains to the south into an unnamed tributary which flows into West Fork Clear Creek at a point about 20 miles from the Colorado River.

Bangs is predominently underlain by the Bonti-Owens soils. These soils are generally moderately deep, fine sandy loam overlying a strongly cemented sandstone horizon that appears at a depth of about 20 inches. Bonti-Owen soils have moderately slow internal drainage and permeability, thereby placing moderate restrictions on septic tank filter fields.

Population data developed by the Texas Water Development Board for use in this study indicate a slight increase in population is expected for Bangs over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,214 | 1,220 | 1,260 | 1,300 |

The land use is generally typical of that of other small cities which are characterized by scattered residential development with commercial and public facilities concentrated in the central areas of the City and along major thoroughfares. The economic resource base is primarily agricultural with no significant industrial contribution.

The City is accessible by U.S. Highway 67 and is served by the Atchison, Topeka, and Santa Fe Railroad. The anticipated growth potential is

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slight due to lack of any industrial development potential. The City's close proximity to Brownwood accounts for the possibility of the acquisition of new residents who would choose to live in a small town and would commute to work.

Treated water for Bang's municipal water supply system is purchased in Brownwood from the Brown County Water Improvement District No. 1. Storage for the system is provided by three ground storage tanks with a total holding capacity of 375,000 gallons and one elevated tank with a 50,000 gallon capacity. No ground water sources are utilized at the present time. The projected municipal water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.13 | 0.13 | 0.16 | 0.19 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows (mgd): | 0.10 | 0.10 | 0.11 | 0.11 |
| BOD (lb./day): | 210 | 220 | 230 | 250 |
| TSS (lb./day): | 240 | 260 | 280 | 300 |

The existing sewage collection system is shown on Plate WCT-1. An analysis of the sewer mains and the 8-inch outfall line indicates that they apparently have sufficient capacity to handle the existing flows.

The existing sewage treatment plant is located south of Bangs near F.M. 586 as shown on Plate WCT-1. The plant utilizes an Imhoff tank for primary treatment followed by a Dunbar bed for secondary treatment. A Dunbar bed is basically a bed of sand or gravel through which effluent is allowed to filter and is then collected in an underdrain system. Specifically, sewage first passes through a manually-cleaned bar screen then over a V-notch weir into the circular Imhoff tank which has a rectangular flow through chamber. Effluent then is flooded over the surface of one of the three sections of the Dunbar bed and is collected in an underdrain system and discharged into a tributary of the West Fork of Clear Creek. Occasionally, it becomes necessary to bypass the Dunbar beds and discharge from the Imhoff tank directly into the creek. This can occur during prolonged periods of wet weather when the Dunbar bed will not dry out properly so it can be maintained, or during a major maintenance project on the Dunbar bed when all three sections must be put out of service. Sludge is drawn off the Imhoff tank and place in a sludge pit to dry and is subsequently used as fertilizer.

The design capacity of this plant is 0.048 mgd. It is estimated that the plant serves a population of 1,400, and reportedly receives an average flow of 0.08 mgd. Laboratory reports indicate that at times the effluent BOD and TSS readings are under 20 ppm, and at other times they run over 100 ppm. Available sampling data published by the TSDH and TWQB is as follows:

Influent and Effluent Data (mg/l)

| | TSDH (6/72) | TWQB (4/70) |
|---|---|---|
| Raw BOD | 270 | 120 |
| Raw TSS | 270 | 133 |
| Final BOD | 45 | 21 |
| Final TSS | 35 | 16 |

Generally, the existing plant is in poor operating condition. Although the Imhoff tank appears structurally sound, it is presently overloaded. The Dunbar bed is overloaded and is in need of a major overhaul. The

sludge pit is also insufficient in size, fails to meet health requirements by not having permanent concrete sidewalls, and allows underdrainage to discharge directly into the creek. Perhaps the most serious condition is the occasional severe hydraulic overloading of the plant which causes essentially raw sewage to be discharged into the receiving stream.

All of the effluent is discharged in a tributary of the West Fork of Clear Creek. However, an adjacent landowner pumps water from the creek immediately below the plant site for irrigation use during four to five months of each year. The landowner has an earthen holding pond located about 0.2 mile west of the plant site and has roughly 100 acres of grassland and small grains available for spray irrigation.

No water treatment plant wastes are produced in this area nor are there any significant areas where private septic tanks are used. Also there is no significant industrial or agricultural waste produced in this area, nor is any anticipated in the future.

The existing sewage collection system serves essentially all of the major developed areas of the City at the present. A 6-inch sewer extension in the northeast sector of the City should be built in the future as shown on Plate WCT-1. The estimated total cost for this extension is $16,000. Since the population projected for 1990 is only four percent greater than the 1970 population, the collection system should serve the needs of the City with only minor extensions and expansions as needed.

The existing sewage treatment plant for the City of Bangs is 22 years old and is presently overloaded and needs major repair and expansion in order to function properly. Due to the high cost of renovating the existing plant and the high maintenance requirements of the Dunbar beds, it is recommended that a new conventional secondary treatment plant be constructed. The City is currently considering construction of a 0.19-mgd activated sludge plant operated in the extended aeration mode of a type commonly referred to as a "race track" or oxidation ditch. It is characteristic of the activated sludge process that extended aeration is most efficient at a capacity range below that needed by the City. It would therefore be suggested that the City consider an activated sludge secondary treatment facility operated in the contact-stabilization mode unless another mode of operation can be justified. New sludge drying beds would be constructed for sludge disposal with the old Imhoff tank converted for use as a chlorine contact chamber. The total capital

cost, including engineering and contingencies, for construction of these conventional secondary facilities by 1977 is estimated to be $157,000. Annual operation and maintenance costs are estimated to be approximately $14,000.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge contituents that will be utilized to define "secondary treatment" will be attainable by a treatment process such as proposed for Bangs, and the City should be in full compliance with the law until 1983. At that time, the City would need to either install costly tertiary facilities that it could neither afford to purchase or maintain, or may eliminate all discharge of waste by utilizing irrigation to dispose of effluent. In light of the increasing need for irrigation water in the area, this objective should be pursued immediately with a goal of irrigation of all effluent by 1983. It is recommended that a contractual agreement with individual landowners be utilized to insure that all effluent is taken for irrigation, with the landowners providing the necessary facilities for pumping, storage, and spray irrigation. However, the City has the alternative of irrigating its own land, which would require the City to acquire the necessary land and irrigation facilities. The estimated cost of the irrigation facilities and land for this alternative are as follows:

Irrigation Costs

| | |
|---|---|
| 4.1 Ac. 60-day Irrigation Holding Pond | $47,000 |
| Irrigation Equipment | 44,000 |
| 24 Ac. Land at $250 per acre | 6,000 |
| Total Cost | $97,000 |

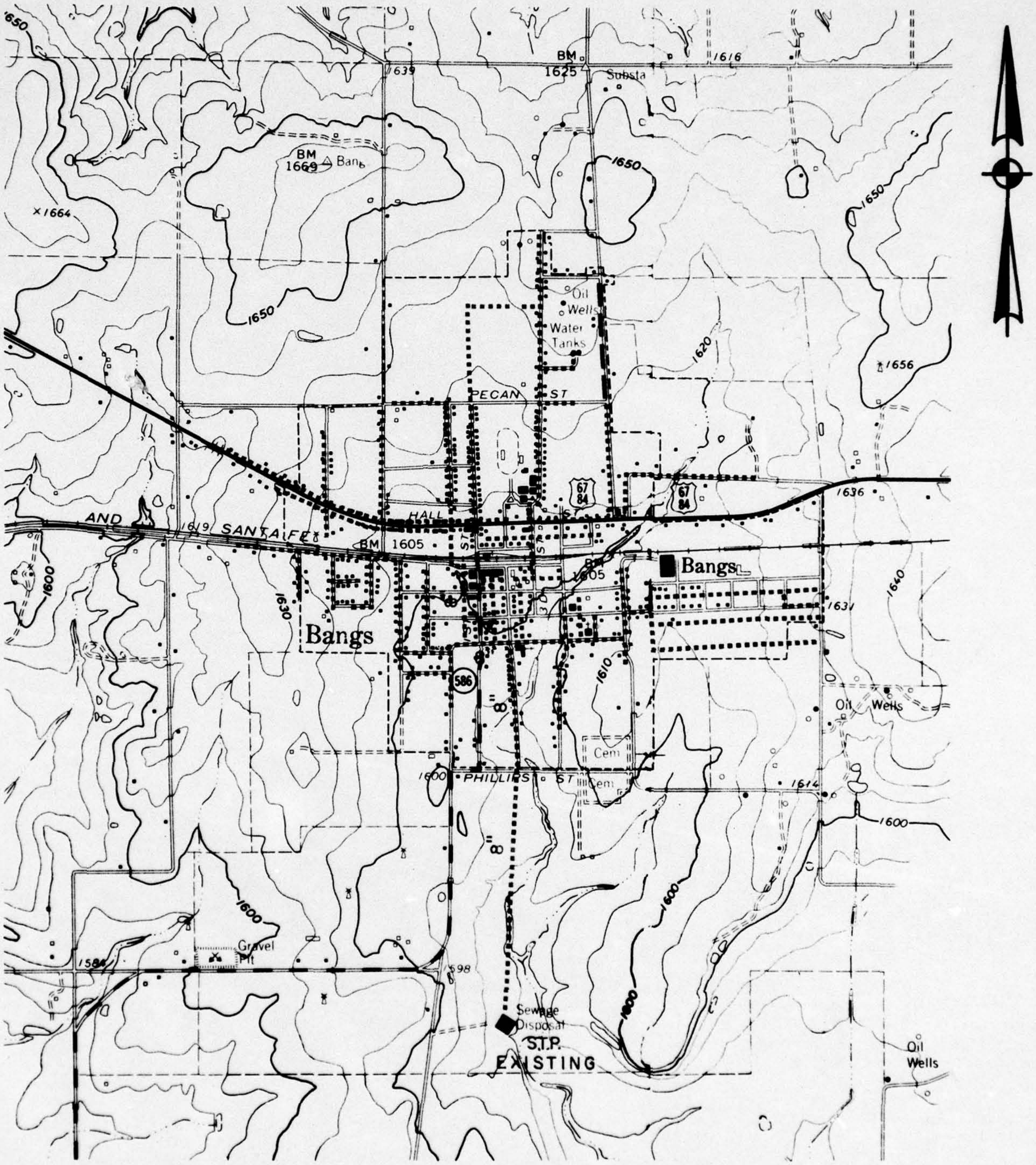
The annual operation and maintenance expenses are anticipated to be about $11,000.

In conclusion, it is believed that the most practical and economical way to meet the requirements of the law is to build a new activated sludge secondary plant and to initiate irrigation of all effluent by 1983 as herein recommended. Environmentally, such improvement to the City of

Bang's existing wastewater system will have a positive effect. The new plant will alleviate the pollution imposed on the creek due to the inadequacy of the existing plant to consistently produce a good effluent. Irrigation of the effluent will provide for a most valuable reuse of treated wastewater, since the area is seasonally semi-arid. In addition to eliminating discharge of treated wastewater to the creek, irrigation of effluent will make it possible to produce quality crops of grasses and small grains from the land to which it is applied.

It is therefore, recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Bangs wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $157,000, including engineering and contingencies.
2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $119,000, including engineering and contingencies.
3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $84,000, including engineering and contingencies.




## LEGEND

- EXISTING SEWER LINE
- PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

## BANGS, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE: WCT-1

## AREAWIDE PLAN
## FOR
## LAKE BROWNWOOD AREA - BROWN COUNTY, TEXAS

Lake Brownwood, a fresh water impoundment located nine miles north of Brownwood, Texas, is owned and operated by the Brown County Water Improvement District No. 1. The lake is fed by Pecan Bayou from the north and by Jim Ned Creek from the west. In addition to being a major source of irrigation water, Lake Brownwood supplies water for the communities of Brownwood, Early, Bangs, Santa Anna, and Zephyr. The lake is also utilized for recreation and provides some flood control in Pecan Bayou below the reservoir site.

The shoreline development around Lake Brownwood is illustrated on Plate WCT-2, which was prepared from a map dated 1969. Although the northern sector of the lake is not shown, the area illustrated on Plate WCT-2 does include essentially all the major residential and commercial development around the lake. This development primarily consists of Lake Brownwood State Park, the older community of Lake Brownwood, and the newer communities of Lake Shore and Shamrock Shores. None of these built-up areas are presently incorporated.

Generally, the topography of this area is moderately to strongly sloping near the lake shore and is rolling with gentle to moderate slopes beyond the valley in which the lake is situated. As might be expected, this area drains directly to the lake or to tributaries of the lake.

The study area is primarily underlain by soils of the Tarrant-Tobosa-Owens type. The Tarrant soils consist of 6-20 inches of calcareous clay underlain by limestone and occur on the gently sloping to hilly uplands. The Tobosa soils occur in the shallow valleys and wide divides where the topography is flat to gently sloping and consist mainly of blocky, calcareous clay to depths of six feet. The Owens soils occur in the undulating to strongly sloping uplands and generally consist of about 16 inches of blocky, calcareous clay underlain by shaley clay with soft, rippable shale occurring at 3 feet in some places. Limitations to septic tanks are severe due to the shallow depth to bedrock in the Tarrant soils and due to the very low permeability of the Tobosa and Owens soils. Limitations to sewage lagoons are also severe due to the shallow depth to bedrock in the Tarrant soils, but are only slight to moderate in the Tobosa and Owens soils.

No population data are available for the development around Lake Brownwood. Although there are many permanent residences located mainly in the communities of Lake Brownwood, Lake Shore, and Shamrock Shores, they are minor in comparison to the number of weekend and vacation dwellings located around the lake. Naturally, the total domestic waste produced in the area fluctuates highly, depending on the number of persons visiting the area at a given time. However, no water use or waste load data are available for the area. Since the population of Brown County is projected to grow only slightly in the future and the populations of the nearby counties are projected to stay about the same or decline significantly, it would appear that future development around Lake Brownwood would also be slight. Therefore, in the future, it is anticipated that the water usage and domestic wastewater produced in the area will remain essentially the same as that which presently exists.

Present methods of treatment and disposal of wastewater are mainly private septic tanks. However, some collection and treatment facilities are now in existence. A discussion of present treatment methods and future needs by location follows in the succeeding paragraphs.

Lake Brownwood State Park

Lake Brownwood State Park is located on a peninsula approximately 1.5 miles northwest of the Brownwood Dam. The park encompasses 450 acres and includes lodging, camping, and recreational facilities. Before 1972, domestic wastewater was collected in a sanitary sewer and was subsequently treated in septic tanks. In 1972, however, a new 0.01 mgd extended aeration package plant was constructed and placed into service. This plant serves the northern portion of the park as shown on Plate WCT-2. The plant consists of a bar screen, aeration chamber, clarifier, aerobic sludge digestor, and chlorination facilities. The effluent from the plant is utilized for spray irrigation of 0.3 acres of grassland and is not discharged into Lake Brownwood. The monthly average flow BOD and TSS permitted by the TWQB are 0.010 mgd, 20 ppm, and 20 ppm, respectively.

Currently, construction of a 0.025 mgd extended aeration package plant to serve the eastern and southern sections of the park is in progress. This new plant will be similar to the 0.01 mgd plant. The effluent from the plant will be used for spray irrigation of a 5-acre tract of grassland and no discharge will be made to Lake Brownwood. Coincidental with the construction of the new treatment plants, a new collection system is also being constructed to replace the old, delapidated system.

The new facilities described above should serve the park through the study period, providing the facilities continue to be properly operated and maintained. The only deficiency that currently exists appears to be the size of the spray field utilized for disposal of effluent from the 0.01 mgd plant. It is recommended that this spray field be increased from 0.3 acres to 2.0 acres. The cost of this improvement is estimated to be about $5,000, which includes engineering and contingencies.

It is recommended that the aforementioned no-discharge plan be continued. However, should Lake Brownwood State Park wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $139,000, including engineering and contingencies.
2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $123,000, including engineering and contingencies.

Community of Lake Brownwood.

The community of Lake Brownwood is located just west of the south end of Brownwood Dam, as shown on Plate WCT-2. The community is older than much of the development around Lake Brownwood and consists of both temporary and permanent residences and of some commercial establishments which are mostly marinas.

The Brown County Water Improvement District No. 1 owns, operates, and maintains a sanitary sewage collection and treatment facility which serves this community. The sewage is pumped to an upland site where it is treated in a large septic tank. Information concerning the actual layout of the collection system and the location of the septic tank was not available for this study. Therefore, this information is not presented on Plate WCT-2.

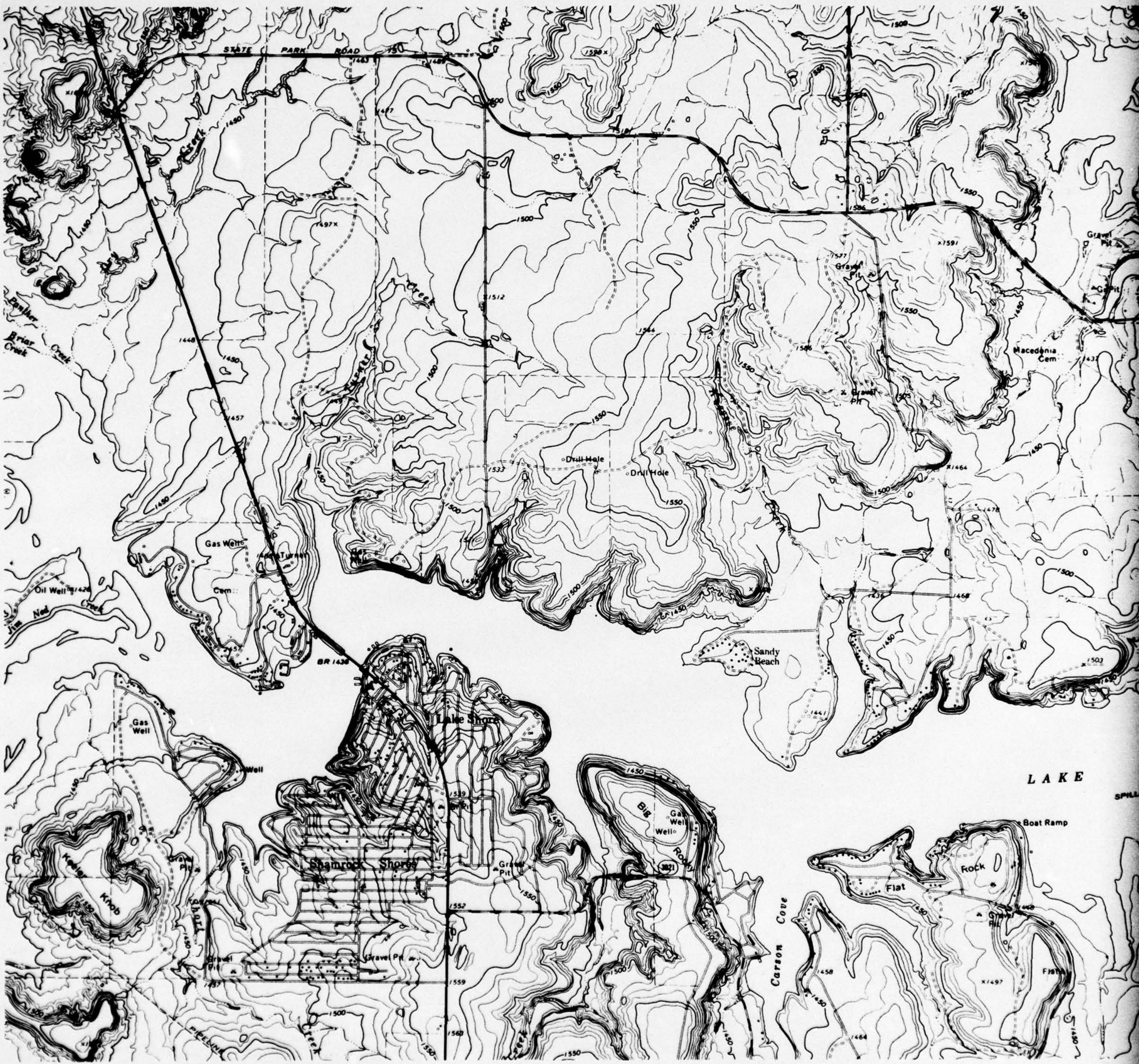
No information concerning the present physical condition of this system or the current status of operation and maintenance was available, nor was there any indication that any significant problems exist with the existing system. Therefore, no improvements to the existing system are recommended herein.

Lake Shore, Shamrock Shores, and Other Development.

Lake Shore and Shamrock Shores are located on the south shore of Lake Brownwood near the point where State Highway 279 crosses Lake Brownwood. This development, as well as the other scattered developments around the lake, consists of temporary and permanent residences, lodges, campgrounds, and marinas.

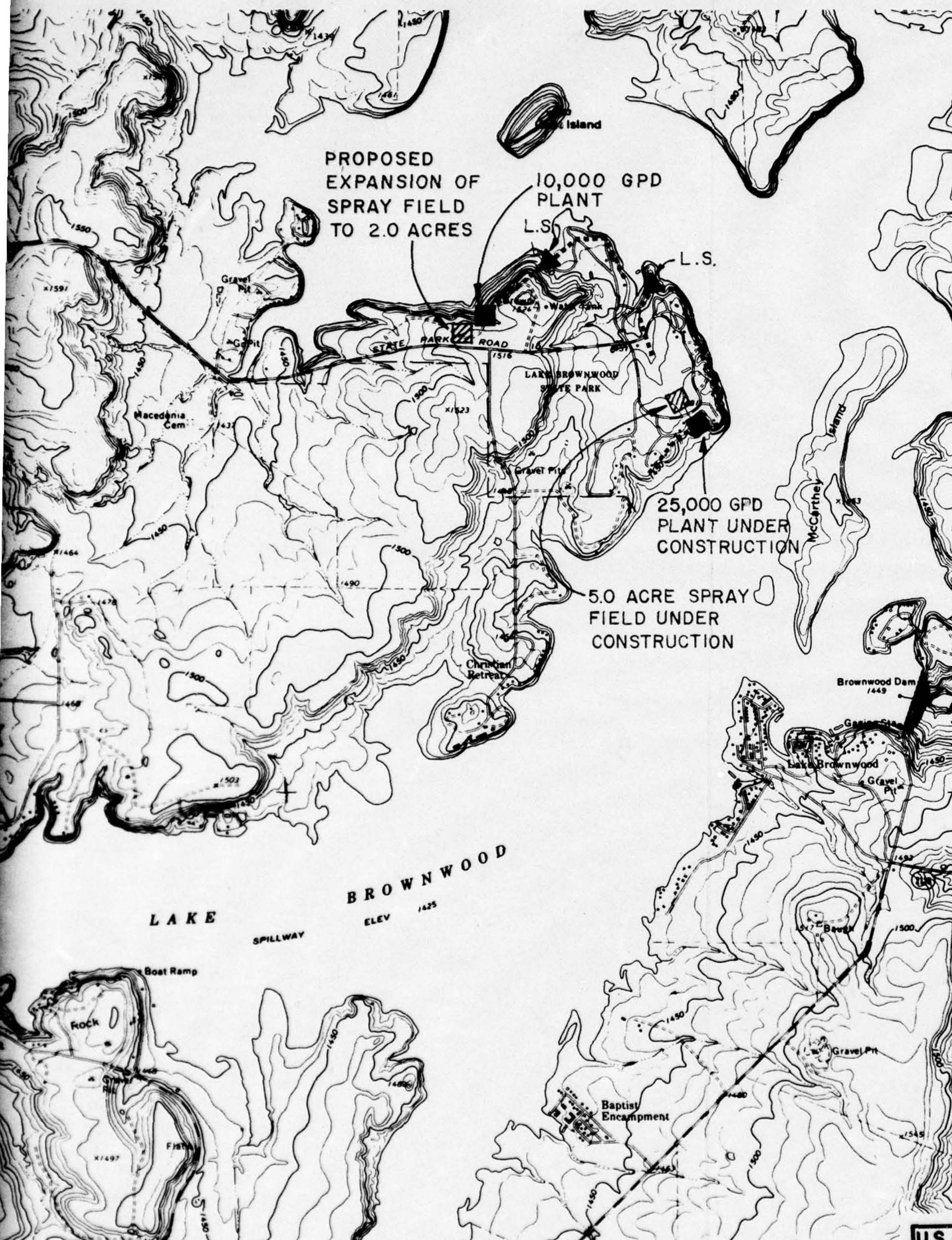
The present method for domestic wastewater disposal for these areas is private septic tanks. This method of treatment has apparently served adequately in the past, as no information was available to indicate otherwise. Therefore, no improvements to existing facilities or new facilities are recommended herein. However, should a definite need be demostrated in the future, then it is recommended that any necessary improvements be made.

In conclusion, it should be noted that the Brown County W. I. D. No. 1 does conduct bi-weekly inspections of the shoreline of Lake Brownwood on a year-round basis. During these inspections, random water samples are taken near the shoreline below existing developed areas in order to monitor the quality of the lake water and to identify any major sources of wastewater pollution should such occur. According to information available, no major problems have been located which can be attributed to pollution from septic tank effluents. It is recommended that this program of shoreline inspections and water sampling be continued in order to maintain and protect the quality of the water in Lake Brownwood.




SANITAR

LIFT ST




## LEGEND

- SANITARY SEWER
- LIFT STATION
- SEWAGE TREATMENT PLANT
- EFFLUENT SPRAY FIELD

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE BROWNWOOD AREA

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 3000' | PLATE WCT-2

AREAWIDE PLAN
FOR
CLYDE, TEXAS

The City of Clyde is an incorporated, general law municipality situated in the northwestern portion of Callahan County at the intersection of Interstate Highway 20 and F.M. 604 approximately 10 miles east of Abilene, Texas. The incorporated area encompasses approximately 600 acres and lies within the jurisdiction of the West Central Texas Council of Government.

The City lies just on the south side of the drainage divide between the Brazos and Colorado River Basin. The topographic relief is moderate with ground elevations decreasing about thirty feet to the southeast. The City is drained by Kaiser Creek, a tributary of Pecan Bayou, to the southeast.

The City is underlain by Nimrod-Windthorst-Stephenville soils. These soils generally have a loose, slightly acid to neutral, fine sand to loamy sand surface, 10 to 36 inches thick, over very stiff, massive, slightly acid, sandy clay. Surface permeabilities range from 0.2 to 0.8 inch per hour. There are moderate limitations on both septic tanks and sewage lagoons due to the soil's permeability.

Population data developed by the Texas Water Development Board for use in this study indicate that a slight increase in population is expected for Clyde over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,635 | 1,680 | 1,720 | 1,730 |

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity and

gravel excavations. Accessible by Interstate Highway 20, the City is served by the Texas and Pacific Railroad. Anticipated growth potential is fair due to the proximity of Abilene, Texas.

The municipal water supply is presently obtained solely from ground water sources and is drawn by 16 wells with a total pumping capacity of 0.75 mgd. Storage is provided by an elevated reservoir with a capacity of 0.05 mg and a ground reservoir with a capacity of 0.10 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.16 | 0.21 | 0.22 | 0.30 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows were projected for the City by the TWQB as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.14 | 0.14 | 0.15 | 0.15 |
| BOD in lb./day: | 280 | 300 | 310 | 330 |
| TSS in lb./day: | 330 | 350 | 380 | 400 |

The existing sewage collection system is shown on Plate WCT-3. An analysis of the sewer mains and the 8-inch outfall line indicated that the system has adequate capacity for existing flows, with the exception that the outfall line may be slightly overloaded under present conditions.

The existing sewage treatment plant is located south-southeast of Clyde as shown on Plate WCT-3. The plant utilizes a 40-foot diameter clarifier for primary treatment, followed by two oxidation ponds in series for secondary treatment. Specifically, sewage first passes through a communitor and a manually-cleaned bar screen then through a Parshall flume into the lift station wet well. The lift station pumps the raw sewage to the primary clarifier. The effluent from the clarifier flows by gravity through two oxidation ponds in series and is discharged into Kaiser Creek. Sludge from the primary clarifier is scraped into an anaerobic digestion compartment and is periodically wasted to two sludge drying beds. The dried sludge is used as fertilizer.

The design capacity of the plant is 0.32 mgd. It is estimated that the plant serves a population of about 2,000 and receives an average flow of 0.15 mgd. The current monthly average discharge, BOD and TSS permitted by the TWQB are 0.32 mgd, 20 ppm, and 20 ppm, respectively. Available sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent and Effluent Data (mg/l)

| | TSDH (4/72) | TWQB (4/72) |
|---|---|---|
| Raw BOD | 140 | 140 |
| Raw TSS | 160 | 156 |
| Final BOD | 40 | 40 |
| Final TSS | 185 | 185 |

Generally, the plant has been well operated and maintained. The existing site covers about 15 acres, of which about 8 acres is available for expansion. All of the effluent is currently discharged to Kaiser Creek; however, a landowner immediately below the plant site does irrigate approximately 20 acres with water from Kaiser Creek during the dry summer months when the stream flow is usually less than the average sewage flow.

Although the City presently does not have a water treatment plant in operation, construction of a water treatment plant is now in progress

on a site located approximately 0.75 miles south of the intersection of F.M. Road 18 and F.M. Road 2700. The above treatment plant was scheduled for completion in June 1973. The water treatment plant will be a typical filtration process and will produce some wastewater in the form of filter backwash water and chemical wastes. Disposal of this waste in an evaporation pond is planned with no significant discharge to Kaiser Creek.

There are some areas of town which are currently served by privately-owned septic tanks. These areas consist of the scattered development north of Interstate 20, some scattered dwellings along the first east-west road south of F.M. Road 18 in the west central section of the town, and the denser development along the streets where proposed sewer extensions are shown on Plate WCT-3. There are no abandonment plans for these private systems at present. The soil in this area is somewhat tight but is quite deep; therefore, septic tanks should not pose serious problems unless development becomes dense enough to overload the assimulative capacity of the soil.

There is no significant industrial or agricultural waste produced within the corporate limits of Clyde or the immediate vicinity, nor are there any such wastes anticipated in the future.

Expansion of the existing collection system to serve the three areas as delineated on Plate WCT-3 should be considered. In addition, the 8-inch outfall line should be paralleled with a 10-inch relief outfall sewer also shown on Plate WCT-3. The estimated construction cost of these improvements is as follows:

| Proposed Improvements | |
|---|---|
| Northeast Area | $ 43,000 |
| Northwest Area | 22,000 |
| Southeast Area | 55,000 |
| Outfall Relief Sewer | 108,000 |
| Total Cost | $228,000 |

Although as stated previously the existing 9-year-old treatment plant has been maintained in good operating condition, under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment

technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define "secondary treatment" will not be attainable by a treatment process such as that employed by Clyde, and the City will be required to implement a higher level of waste treatment prior to 1977. In lieu of constructing costly conventional secondary treatment facilities in order to meet the 1977 requirements of the law, it is proposed that the effluent be used entirely for year-round irrigation of farmland so that no discharge occurs. It is suggested the City enter into a contractual agreement with nearby landowners for the irrigation of all effluent from the plant. Under this arrangement, the landowner would supply the necessary pumpage, irrigation equipment, and holding ponds sufficient to store the effluent during non-irrigable periods. The City, however, has the alternative of owning its own disposal system which would require acquisition of necessary land, retention ponds, and irrigation facilities. The estimated 1977 capital costs are $89,000 which includes a 5.4 acre holding pond, irrigation equipment 24 acres of land, and engineering and contingencies.

Associated annual operation and maintenance costs are estimated to be about $12,000.

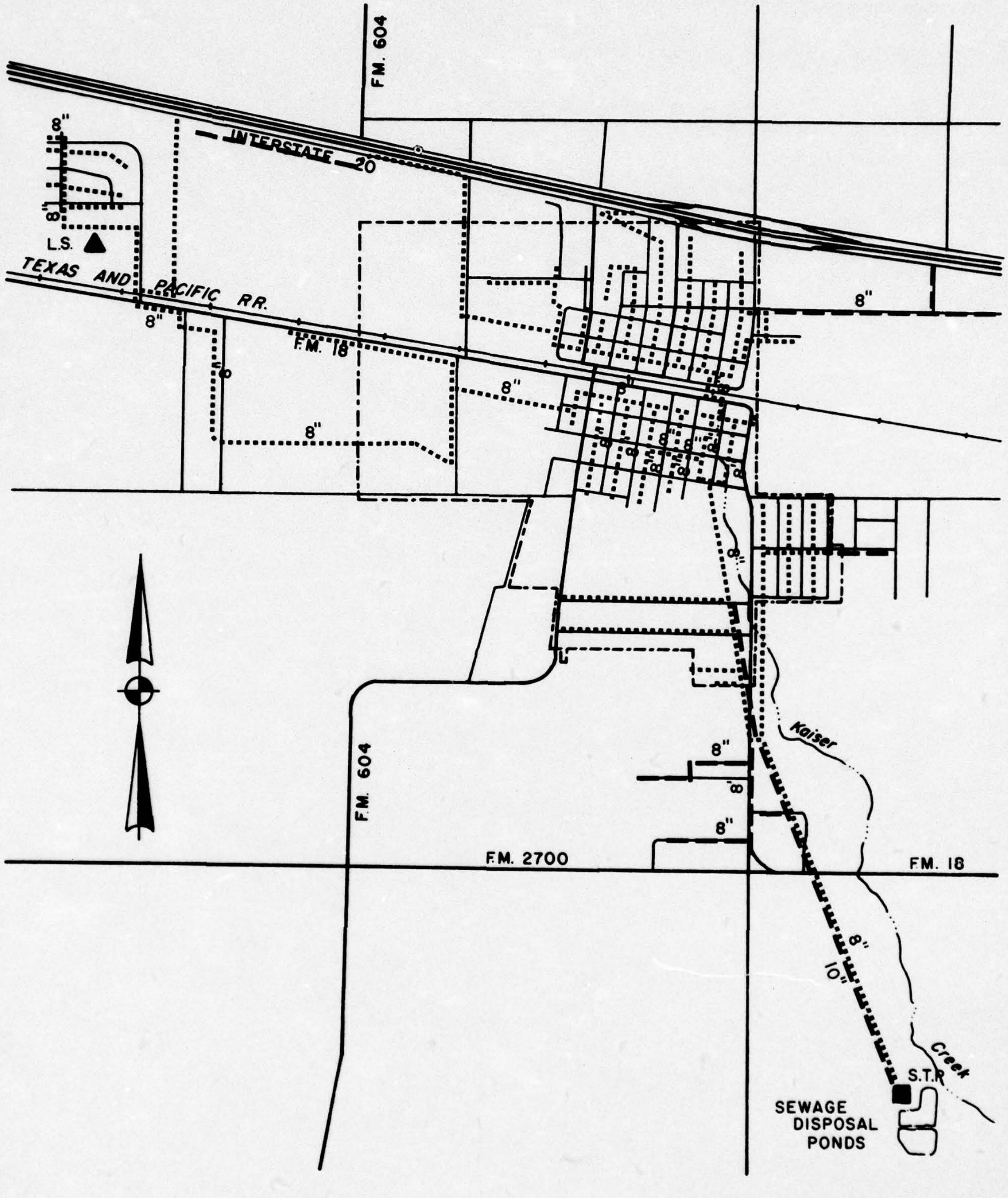
The most practical and economical method to meet the requirements of PL 92-500 would be to initiate irrigation of all effluent from the plant. The recommended improvements would have a net positive effect by eliminating any adverse conditions that may be associated with the present discharge. During the dry periods of each year, the stream flow of Kaiser Creek below the sewage treatment plant is largely composed of treatment plant effluent which adversely affects the quality of the stream. Since the area is seasonally semi-arid, irrigation with the effluent will provide for a most valuable reuse of treated wastewater.

Therefore, it is recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Clyde wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $100,000, including $23,000 for engineering and contingencies.

2. **By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $106,000, including engineering and contingencies.**

3. **By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $103,500, including engineering and contingencies.**




## LEGEND

·············· EXISTING SEWER LINES

— — — — PROPOSED SEWER LINES

NOTE: ALL UNLABELED LINES ARE 6"

| |
|---|
| U.S. ARMY ENGINEER DISTRICT, FORT WORTH<br>CORPS OF ENGINEERS<br>FORT WORTH, TEXAS |
| WASTEWATER MANAGEMENT STUDY<br>COLORADO RIVER & TRIBUTARIES, TEXAS |
| CLYDE, TEXAS |
| TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR |
| SCALE: 1" = 2000' PLATE: WCT-3 |

## AREAWIDE PLAN
## FOR
## CROSS PLAINS, TEXAS

The City of Cross Plains is an incorporated, general law municipality situated in the southeastern corner of Callahan County at the intersection of State Highways 36 and 206, approximately 30 miles northwest of Brownwood, Texas. The incorporated area encompasses approximately 700 acres and is located within the jurisdiction of the West Central Texas Council of Governments.

The City slopes to the west with ground elevations decreasing approximately 70 feet in that direction toward Turkey Creek, which provides drainage.

The City is predominantly underlain by Nimrod-Windthorst-Stephenville soils. These soils have a loose, slightly acid to neutral, fine sand to loamy sand surface, 10 to 36 inches thick, over very stiff, massive, slightly acid, sandy clay surface. Permeabilities range from 0.2 to 0.8 inch per hour. Septic tanks and sewage lagoons both have moderate limitations due to the soil's permeability.

The Darnell-Owens soil type underlies the southwestern portion of the City. The Darnell soil has a friable, slightly acid, fine, sandy loam surface, 6-10 inches thick, over noncalcareous sandstone. Owens soils have a calcareous clay surface, 5 to 10 inches thick, over very firm, blocky to massive, calcareous, clay that grades into calcareous, shaly, clay surface. Permeabilities range from 0.8 to 2.5 inches per hour. Septic tanks have moderate limitations due to the depth to bedrock.

Population data developed by the Texas Water Development Board for use in this study indicate that a slight increase in population is expected for Cross Plains over the next fifty years. The population projections are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,192 | 1,220 | 1,250 | 1,260 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is based on agriculture, primarily peanut farming, with some contribution from local oil field activity. There is no known industrial contribution. Accessible by three State highways, the City is not served by a railroad.

The municipal water supply, obtained solely from ground water sources, is drawn by 27 wells with a total well pumping capacity of 0.39 mgd. The water is stored in three ground reservoirs with capacities of 0.126, 0.126, and 0.060 mg and in an elevated reservoir with 0.060 mg capacity. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.12 | 0.15 | 0.16 | 0.22 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows, projected for the City by the TWQB are as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.10 | 0.10 | 0.11 | 0.11 |
| BOD in lb./day: | 203 | 220 | 220 | 240 |
| TSS in lb./day: | 240 | 260 | 270 | 290 |

The existing sewage collection system is shown on Plate WCT-4. An analysis of the sewer mains and the outfall line indicates the system has adequate capacity to carry existing flows. Only a small percentage of the dwellings in the town utilize private septic tanks.

The existing sewage treatment plant is located approximately one mile south-southwest of the intersection of S.H. 36 and S.H. 279, as shown on Plate WCT-4. The plant utilizes a 25-foot-square Imhoff tank for primary treatment and three stabilization ditches in series for secondary treatment, with no chlorination of the effluent before it is discharged. Specifically, sewage passes through a manually-cleaned bar screen into the Imhoff tank. It then flows by gravity through the stabilization ditches into Turkey Creek. An earthen pit is provided for the wasting of sludge from the Imhoff tank with the dried sludge being used as fertilizer.

The stated design capacity of the plant is 0.125 mgd. It is estimated that the plant serves a population of about 1,100 and reportedly receives an average flow of 0.070 mgd. The monthly average discharge, BOD and TSS permitted by the TWQB are 0.125 mgd, 20 ppm and 20 ppm, respectively. Available sampling data published by the TSDH and TWQB are as follows:

**Influent - Effluent Data (mg/l)**

| | TSDH (9/71) | TWQB (9/71) |
|---|---|---|
| Raw BOD | 70 | 70 |
| Raw TSS | 40 | 35 |
| Final BOD | 45 | 45 |
| Final TSS | 24 | 24 |

Generally, the plant has been poorly operated and maintained, partially due to the lack of an access road to the plant site. The site is neither graded nor fenced and there is little evidence of weed control. The sludge pit is insufficient in size, fails to meet health requirements by not having permanent concrete sidewalls, and does not have proper

underdrainage. The Imhoff tank, although appearing structually sound, is poorly maintained and appears overloaded. The stabilization ditches are heavily silted such that most of the effluent flows down one ditch, overflows the bank, and discharges directly into Turkey Creek, thus bypassing the other two ditches. The ditches are very shallow, heavily choked with algae, and consequently malodorous. During the summer months, an adjacent landowner pumps a portion of the effluent for irrigation of coastal Bermuda grass; otherwise, the effluent is discharged to Turkey Creek.

The City currently obtains its water supply from wells; consequently, there is no water treatment plant wastes produced in this area. There are no significant industrial or agricultural wastes produced within the corporate limits of Cross Plains or the immediate vicinity, nor are there any such wastes anticipated in the future.

Should the City wish to extend the existing collection system to serve the dwellings in the southeast sector of town as indicated on Plate WCT-4, the estimated cost including engineering and contingencies would be $49,000.

The existing sewage treatment plant is about 43 years old and is in poor condition. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by a treatment process such as employed by Cross Plains, and the City will be required to implement a higher level of waste treatment prior to 1977. In order to meet the 1977 requirements of the law, it is recommended that a new treatment plant of the contact-stabilization type be constructed. All facilities would be new, with the exception that the old Imhoff tank might possibly serve as a chlorine contact chamber. Construction of the new plant would include site grading and fencing, an access road, and a wet-weather and emergency holding pond. The construction costs are estimated to be about $141,000 including engineering and contingencies, with annual operation and maintenance of the new plant estimated to be $12,500.

In lieu of constructing costly tertiary treatment facilities in order to meet the best practicable treatment objective as required by the law, it is recommended that irrigation of effluent be performed such that no discharge occurs into Turkey Creek. In light of the increasing need for

irrigation water in the area, this objective should be pursued immediately with the goal of irrigation of all effluent being achieved by 1977. It is recommended that a contractual agreement with a landowner be utilized to insure that all effluent is taken for irrigation. The landowner would provide the necessary facilities for pumping, storage, and spray irrigation. However, the City has the alternative of owning and operating the irrigation system. This alternative would require the City to acquire the necessary land and irrigation facilities. The cost to the City for these facilities, including a 3.9-acre holding pond, irrigation equipment 24 acres of land, and engineering and contingencies is estimated to be $98,000.

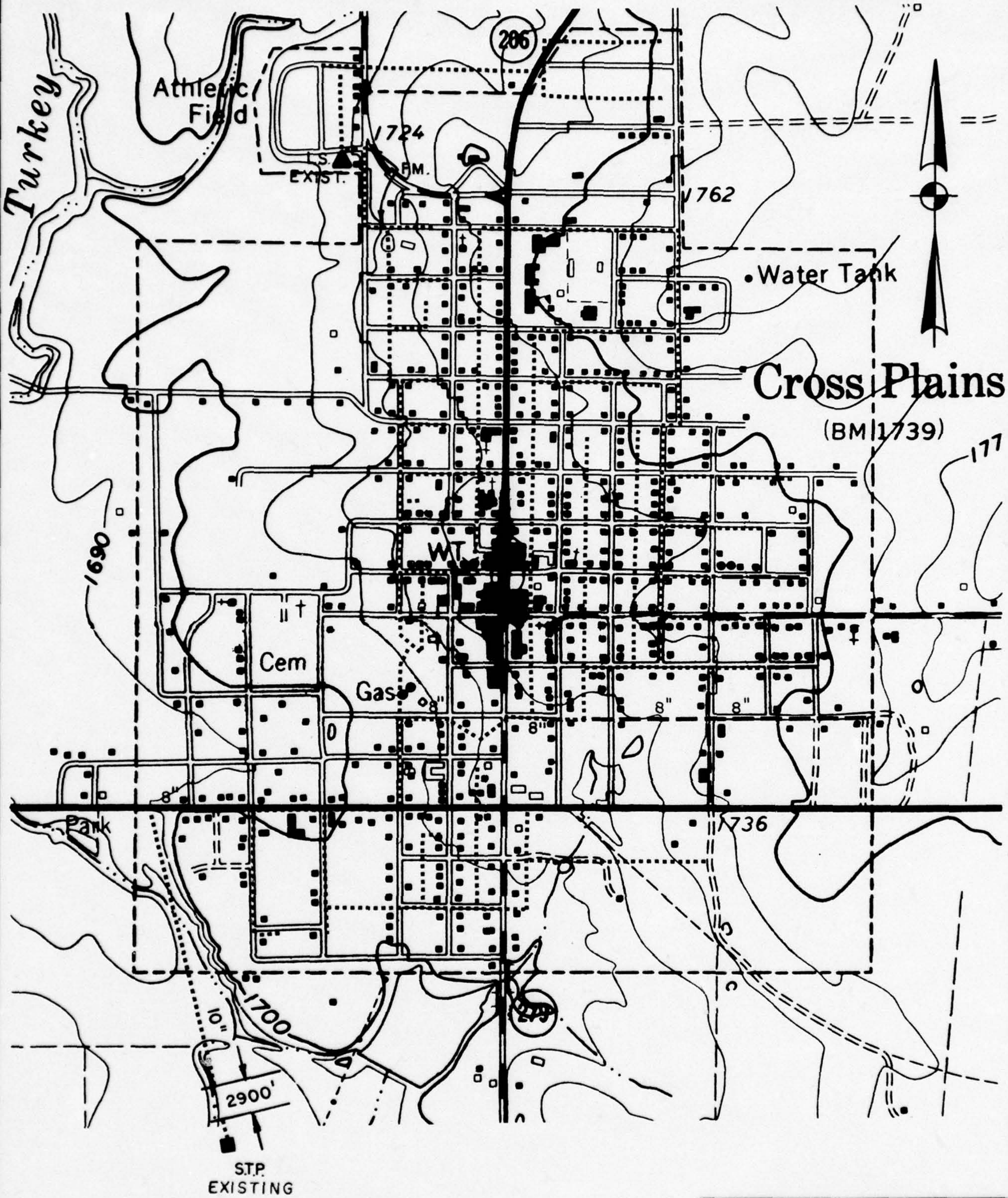
The associated annual cost for operation and maintenance is estimated to be $11,000. It should be pointed out that although irrigation of all effluent from the existing plan would eliminate pollution of Turkey Creek, it is anticipated that the existing plant, even with costly improvements, may not be able to produce an effluent suitable for continuous irrigation once standards for such irrigation are set by the appropriate regulatory agency.

The recommended improvements to the existing wastewater system will have a positive environmental effect. The new plant would alleviate the pollution load imposed on Turkey Creek due to the inability of the existing plant to produce an effluent equal to its permit requirements. Irrigation of effluent will provide a most valuable reuse of treated wastewater in a seasonally semi-arid area and will make it possible to produce quality crops of grasses and small grains from the irrigated land.

It is therefore, recommended that all steps necessary to implement the proposedno-discharge plan be undertaken. However, should the City of Cross Plains wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $102,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $74,000, including engineering and contingencies.




## LEGEND

.......... EXISTING SEWER LINE

— — — PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6".

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

CROSS PLAINS, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: WCT-4

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## AREAWIDE PLAN
## FOR
## COLEMAN, TEXAS

The City of Coleman is an incorporated, home rule municipality located in central Coleman County at the intersection of U.S. Highways 283 and 84, approximately 30 miles northwest of Brownwood, Texas. The incorporated area of the City encompasses approximately 2,000 acres. Coleman, the county seat of Coleman County, is located within the jurisdiction of the West Central Texas Council of Governments.

Most of the City grades eastward and drains into Hords Creek, while the southern tip of the City drains southward into Loss Creek. Coleman is afforded moderate topographic relief, sloping eastward with a decline in elevation of approximately 100 feet per mile, with the exception of the southern part of the City where elevation variations are in the 20-40 foot range.

The City is underlain by the Tobosa-Mereta-Tarrant soils. The Tobosa soil type has a crumbly, calcareous, clay surface, 8 to 12 inches thick, over very firm, blocky to massive, calcareous clay underlain by hard caliche-coated limestone at depths of 36 to 60 inches. Permeabilities are generally less than 0.06 inch per hour. There are severe limitations on septic tanks due to the permeability, and only slight limitations on sewage lagoons. Mereta soils have a friable, calcareous clay over friable, granular, strongly calcareous, silty clay or clay loam underlain by a hard, rock-like, caliche layer at 15 to 35 inches. Tarrant soils have a friable, highly calcareous, clay surface, 4 to 8 inches thick, over broken or partly weathered limestone or limestone bedrock at leass than 12 inches beneath the surface. Permeabilities for these two soils generally range from 0.06 to 0.2 inch per hour. Septic tanks again have severe limitations due to the low permeability and depth to bedrock.

Population data developed by the Texas Water Development Board for use in this study indicate a sharp decline in population is expected for Coleman over the next fifty years. The population estimates are as follows:

**Population Projections**

| | | | | |
|---|---|---|---|---|
| Year: | 1970 | 1980 | 1990 | 2020 |
| Population: | 5,608 | 4,560 | 3,690 | 1,900 |

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with no significant industrial contribution. Accessibility is provided by the two U.S. highways previously noted, in addition to three Farm-to-Market roads (206, 53, and 2131). Coleman is also served by the Atchison, Topeka, and Santa Fe Railroad.

The municipal water supply is obtained from three surface water sources, Lakes Coleman and Scarborough to the north and Hords Creek Reservoir to the west. These three sources provide a combined supply capacity of 4.0 mgd. Storage is supplied by ground storage tanks holding a total of approximately 0.78 mg and an evaluated storage tank holding approximately 0.58 mg. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

**Water Use Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.98 | 0.86 | 0.71 | 0.40 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.48 | 0.39 | 0.31 | 0.16 |
| BOD in lb. /day: | 950 | 820 | 660 | 360 |
| TSS in lb. /day: | 1,120 | 960 | 810 | 440 |

The existing sewage collection system is shown on Plate WCT-5. An analysis of the sewer mains indicates that they have sufficient capacity to carry the existing flows. However, the 15-inch outfall line reportedly becomes severely overloaded during wet weather flows, thereby making it difficult for the sewer mains to drain properly. Construction presently in progress includes a 21-inch relief line paralleling the outfall sewer. The collection system serves essentially all of the significantly developed areas of Coleman, with only a few scattered dwellings using private septic tanks.

The existing sewage treatment plant is about 30 years old and is located on the east side of Coleman as shown on Plate WCT-5. The plant utilizes two circular Imhoff tanks for primary treatment, followed by three oxidation ponds in series for secondary treatment. Sludge from the Imhoff tanks is periodically drained to three sludge drying beds with the dried sludge being disposed in a landfill. The City has recently awarded a contract for the construction of a new sewage treatment plant. Construction was scheduled to begin mid-1973 with the old plant to be abandoned when the new plant is placed in service. The new plant will be an activated sludge facility operated in the extended aeration mode. Specifically, raw sewage will flow into the wet well of a new lift station and from there will be pumped to the new pre-treatment unit, which will consist of a bar screen, a grit channel and a flow-measuring device. Thence, the sewage will flow into an oxidation ditch (or "race track"). The effluent from this unit will flow into a final clarifier. The effluent from the clarifier will be chlorinated and used for broad irrigation of 57 acres of terraced land. The existing oxidation ponds will be used for emergency and wet-weather storage; thus, no discharge will normally be made to Hord's Creek. Sludge from the final clarifier will be recycled to the oxidation ditch with excess sludge being wasted to new sludge drying beds. The dried sludge will be disposed on the irrigated land as fertilizer. Current plans are to produce Coastal Bermuda grass on the irrigation site. The irrigation system consists of open ditches feeding manually-valved outlets which flood the terraced sections. An extensive program of surface leveling and terracing was recently completed, providing a good site for this type of irrigation.

The design capacity of the new plant is 0.80 mgd. It is estimated that a population of about 6,000 is served presently and that the average sewage flow is about 0.325 mgd, excluding extremely high flows when the sewage is diluted by infiltrated ground water. The City has applied and received an amended permit from the TWQB allowing an average

monthly flow, BOD and TSS of 0.80 mgd, 20 ppm and 20 ppm, respectively, and requiring a chlorine residual of at least 1.0 mg/l after at least a 20-minute detention time. The old plant is badly deteriorated and presently is not well operated or maintained. The new plant should greatly improve the treatment efficiency and alleviate many of the maintenance problems presently experienced. The present irrigation site should be adequate in size to utilize all of the effluent for irrigation.

The City of Coleman owns and operates two water treatment plants. The main plant is located in the Western Hills addition and is supplied with raw water from Lake Coleman which is about 14 miles north of the City, and from Hords Creek Lake which is about 8 miles west of the City. The other smaller plant is located approximately 5 miles north of the City on Indian Creek and receives raw water from Lake Scarborough, also in this vicinity. The wastewater from both plants is primarily filter backwash water and spent lime sludge. The main plant discharges its wastewater into a private earth tank and the clarified water is subsequently used by the landowner. The Lake Scarborough plant discharges its wastewater into Indian Creek, which is a tributary to Jim Ned Creek. There is no significant industrial or agricultural waste produced within the city limits of Coleman or the immediate vicinity, nor is any anticipated in the future.

The existing collection system is apparently adequate to carry existing flows and serves essentially all significant development in the area; thus, no extensions or additional relief lines are recommended. Since the population is projected to continue to decline, no new service mains are recommended. However, it is recommended that the City exercise every effort toward locating and eliminating major sources of infiltration.

The existing sewage treatment plant is 30 years old and is in poor condition. The new facility presently under construction will alleviate many of the present treatment deficiences.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define "secondary treatment" will be attainable by the new treatment plant, if properly operated and maintained. Therefore, the City will be in compliance with the 1977 requirements, particularly since a significant portion of the effluent will be utilized for broad irrigation.

In lieu of constructing costly tertiary treatment facilities in order to meet the best practical treatment objective by 1983, it is recommended that the City irrigate all of the effluent, such that no discharge occurs to Hords Creek. If the population does decline as projected, the present irrigation site should be sufficient to accomplish total irrigation. In order to provide a retention capacity equal to 60 days of flow, an 8-acre holding facility would be required to supplement the capacity of the existing ponds. The cost for this pond is estimated to be approximately $74,000, including engineering and contingencies, with an associated additional annual operation and maintenance cost of $17,000.

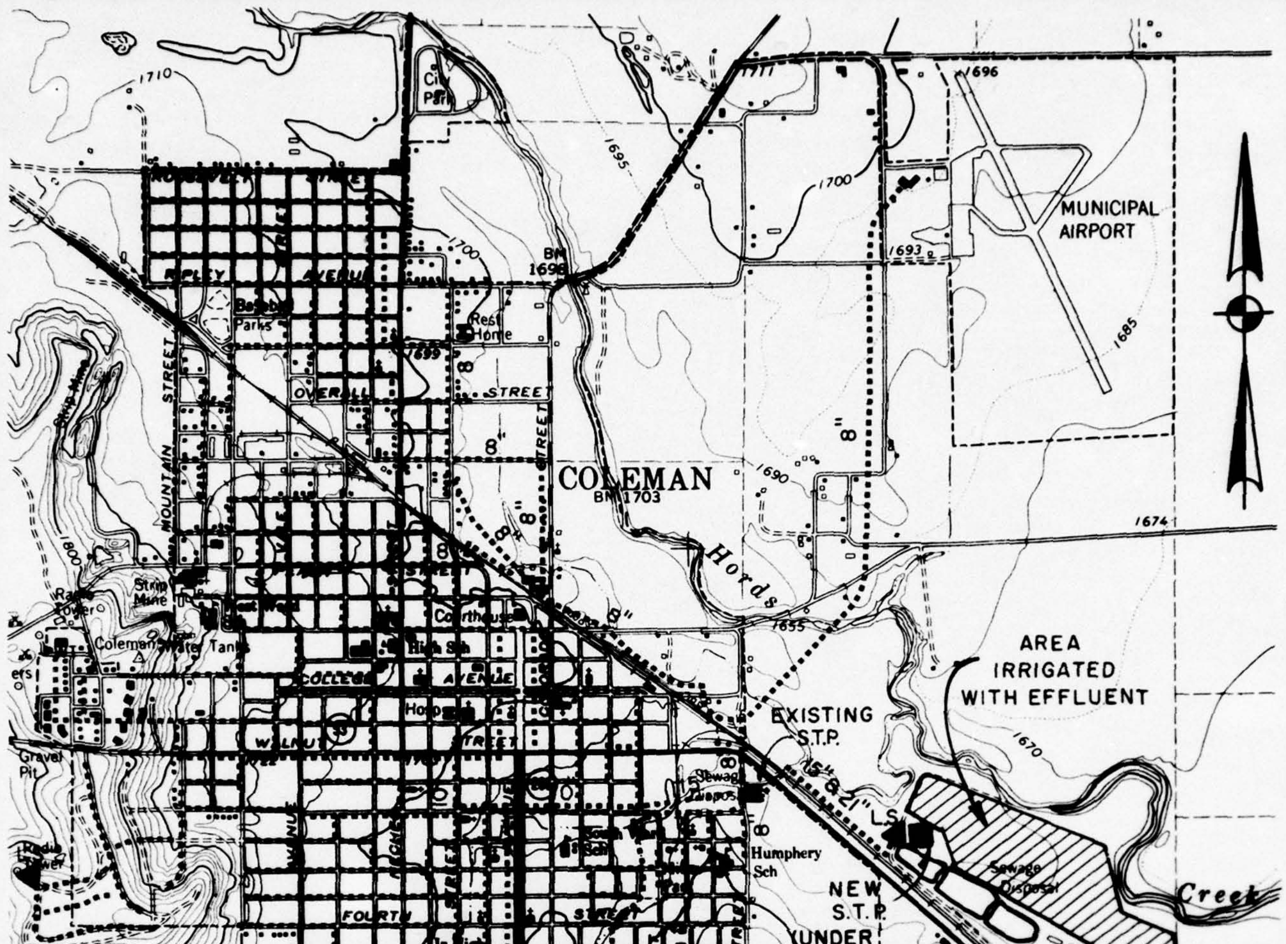
In conclusion, the most practical and economical method to meet the requirements of the PL 92-500 is to utilize irrigation of all effluent. Irrigation of effluent should have a positive effect on the area by providing for a most valuable and economical reuse of the effluent in a seasonally semi-arid area and by making it unnecessary to discharge effluent to the creek. The irrigation of this effluent will make it possible to produce quality crops of grasses and small grains from the irrigated land.

Therefore, it is recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Coleman wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $358,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $196,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $167,000, including engineering and contingencies.




## LEGEND

- ·········· EXISTING SEWER LINES
- — — — PROPOSED SEWER LINES

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

**COLEMAN, TEXAS**

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE: WCT-5

AREAWIDE PLAN
FOR
SANTA ANNA, TEXAS

The City of Santa Anna is an incorporated, general law municipality situated in the east central portion of Coleman County at the intersection of U.S. Highways 67 and 283, approximately 20 miles west of Brownwood, Texas. The incorporated area encompasses approximately 1,100 acres and lies within the West Central Texas Council of Governments.

The Santa Anna Mountains border the City on the north. The western portion of the City slopes to the southwest and is drained by Spring Creek. The central portion slopes to the south and is drained by Horse Creek. The eastern section slopes to the southeast and is drained by an unnamed tributary of Mukewater Creek.

The City is underlain by the Tobosa-Mereta-Tarrant soils. The Tobosa soil type generally has a crumbly, calcareous, clay surface, 8 to 12 inches thick over very firm, blocky to massive, calcareous, clay underlain by hard, caliche-coated limestone at depths of 36 to 60 inches. Permeabilities are generally less than 0.06 inch per hour, creating severe limitations on septic tanks permeability but only slight limitations on sewage lagoons. Mereta soils have a friable, calcareous clay over friable, granular, strongly calcareous, silty clay or clay loam underlain by a hard, rock-like, caliche layer at 15 to 35 inches. Tarrant soils have a friable, highly calcareous, clay surface, 4 to 8 inches thick, over broken or partly weathered limestone or limestone bedrock at less than 12 inches beneath the surface. Permeabilities for these two soils range from 0.06 to 0.2 inch per hour and, consequently, septic tanks again have severe limitations.

Population data developed by the TWDB for use in this study indicate that a substantial decrease in population is expected for Santa Anna over the next fifty years. The population projections are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 1,310 | 1,130 | 950 | 560 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity. The only significant industrial contribution is from a clay-processing plant. Accessible by two U.S. highways, the City is served by the Atchison, Topeka, and Santa Fe Railroad.

The municipal water supply consists solely of surface water resources obtained from Lake Sealy and Lake Santa Anna and of raw water from Lake Brownwood purchased from Brown County Water Improvement District Number 1 and transported to the City's water treatment plant by an 8-inch line. Storage for the system is provided by two elevated reservoirs with capacities of 0.5 mg and 0.05 mg and two ground reservoirs with capacities of 0.055 mg and 0.080 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.16 | 0.15 | 0.13 | 0.08 |
| Industrial Use: | 0.01 | 0.01 | 0.01 | 0.01 |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.11 | 0.10 | 0.08 | 0.05 |
| BOD in lb./day: | 220 | 200 | 170 | 110 |
| TSS in lb./day: | 260 | 240 | 210 | 130 |

The existing sewage collection system is shown on Plate WCT-6. An analysis of the sewer mains and the 10-inch outfall line indicates the existing system has adequate capacity to carry the existing flows. The system serves essentially all significantly developed areas with only a very few dwellings utilizing private septic tanks.

The existing sewage treatment plant is 7 years old and is located approximately 1.2 miles south-southwest of the intersection of U.S. 67 and U.S. 283 as shown on Plate WCT-6. The plant utilizes a rectangular Imhoff tank for primary treatment followed by three oxidation ponds in series for secondary treatment. Specifically, sewage first passes through a manually-cleaned bar screen and grit channel and then through a Parshall flume equipped with a continuous recorded. The sewage then flows into the Imhoff tank from which the effluent flows by gravity through the three oxidation ponds and finally into Horse Creek. No chlorination of the effluent is currently practiced. Sludge from the Imhoff tank is periodically wasted into sludge drying beds, and the dried sludge is used for fill material.

The stated design capacity of the plant is 0.120 mgd. It is estimated that the plant serves a population of about 1,300, and reportedly receives an average flow of approximately 0.090 mgd. The monthly average discharge, BOD and TSS permitted by the TWQB are 0.150 mgd, 20 ppm, and 20 ppm respectively. Available sampling data published by the TSDH and TWQB are as follows:

**Influent - Effluent Data (mg/l)**

| | TSDH (4/70) | TWQB (11/69) |
|---|---|---|
| Raw BOD | 150 | 150 |
| Raw TSS | 180 | 179 |
| Final BOD | 12 | 30 |
| Final TSS | 11 | 139 |

Generally, the plant has apparently been well operated and maintained. The existing site covers about 6 acres, of which about 2 acres would be available for expansion. An adjacent landowner currently pumps effluent from the second oxidation pond and utilizes it to irrigate approximately 20 acres of the 100 acres of land which could be irrigated. The landowner currently pumps at will during the period of April through November, with the irrigating most intense during the summer months. During the remainder of the year, effluent and any excess during the summer is discharged to Horse Creek.

The municipal water treatment plant is located approximately 2.7 miles northeast of Santa Anna. Wastewater produced by the plant consists of filter backwash water and chemical wastes and is discharged into Mud Creek adjacent to the plant site. Retention-evaporation ponds should be considered by the City to eliminate this discharge should the TWQB consider the release significant to water quality downstream.

The only industry in the area which produces any significant wastewater is the tile plant. The wastewater is principally clay and cement wash water and is given preliminary treatment in a settling tank before release to the City sewer. Contribution to the sewage flow from the tile plant is minor when compared to the domestic contribution and presently poses no problem for the treatment plant. No additional significant industrial waste is anticipated in the future.

The existing system is adequate to carry existing flows and serves essentially all of the significant development in the area; thus, no extensions or relief lines are recommended. With only minor extensions and expansions as needed, the system should serve the needs of the declining population.

The existing sewage treatment plant is 7 years old and appears to have been well operated and maintained. However, under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by a treatment process such as employed by Santa Anna and the City will be required to implement a higher level of waste treatment prior to 1977. In lieu of constructing costly conventional secondary treatment facilities in order to meet the 1977 requirements of the law, it is recommended that the effluent be used entirely for irrigation of farmland such that no discharge to the creek occurs. It is suggested the City enter into a contractual agreement with a landowner for the irrigation of all effluent from the plant with the landowner supplying the necessary pumpage, irrigation equipment, and holding ponds which may be necessary to store the effluent during non-irrigable periods. It should be noted that the City has the alternative of owning its own irrigation facilities which would require acquisition of the necessary land and irrigation equipment. The estimated costs, including a 4.1-acre holding pond, irrigation equipment, 24 acres of land and engineering and contingencies of this alternative are $91,000.

The associated additional annual operation and maintenance costs are estimated to be about $11,000.

In order to meet the requirements of PL 92-500 that the best practicable treatment be utilized by 1983, it is recommended that all effluent continue to be irrigated such that no discharge to Kaiser Creek occurs.

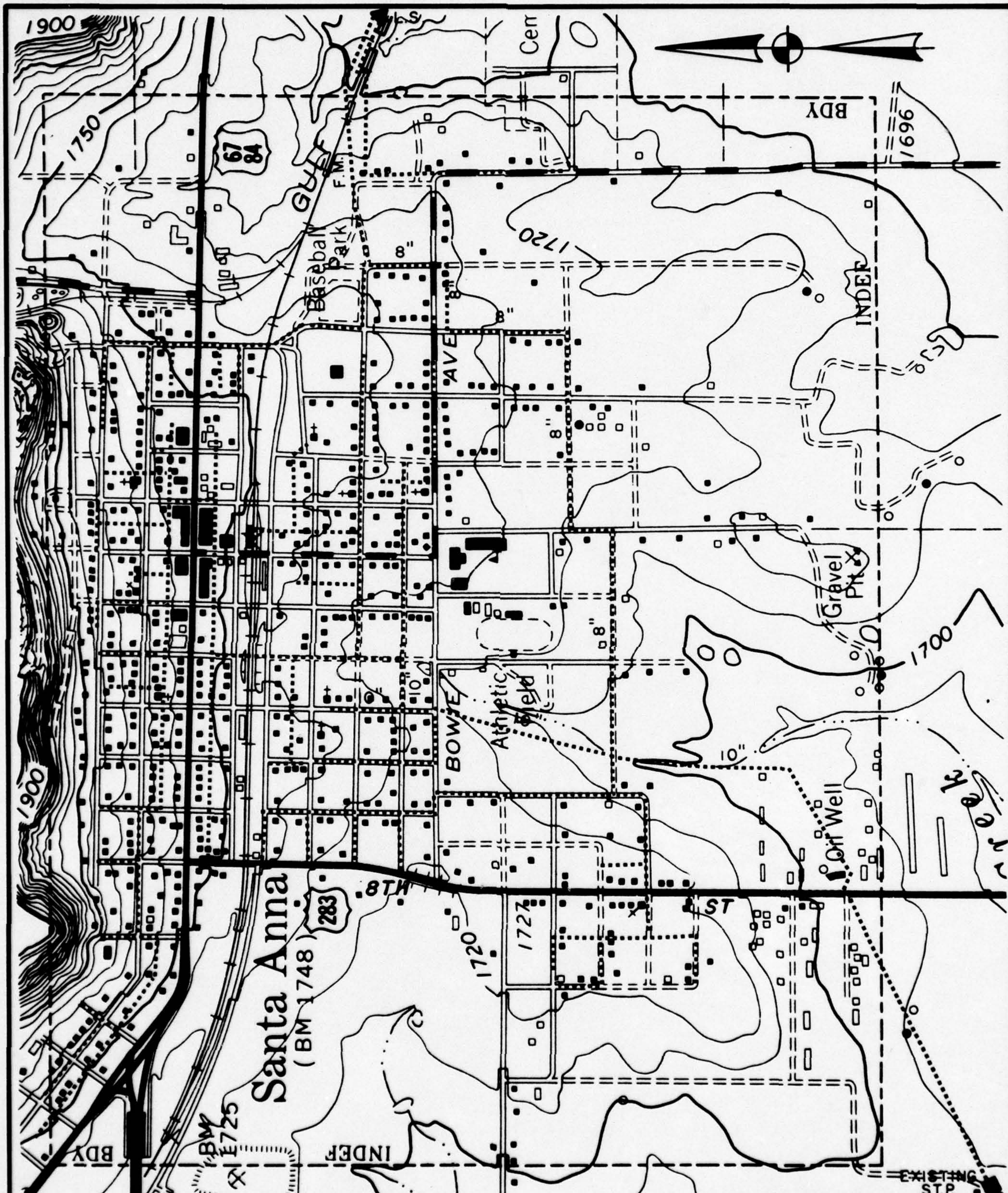
In conclusion, the most practical and economical way to meet the requirements of the law would be to irrigate all effluent. The irrigation of all effluent will eliminate any adverse effects that may be associated with the present discharge and will provide for a most valuable reuse of treated wastewater in a seasonally semi-arid area. In addition to eliminating discharge of effluent to Horse Creek, irrigation will make it possible to produce quality crops of grasses and small grains from the irrigated land.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Santa Anna wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $123,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $92,800, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $85,500, including engineering and contingencies.




## LEGEND

- ············ EXISTING SEWER LINE
- — — — PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

**SANTA ANNA, TEXAS**

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: WCT-6

AREAWIDE PLAN
FOR
COLORADO CITY, TEXAS

Colorado City is an incorporated, home rule municipality located in the central portion of Mitchell County at the intersection of Interstate Highway 20 and State Highway 208, approximately 40 miles east of Big Spring, Texas. The incorporated area encompasses approximately 3,520 acres. Colorado City, the county seat of Mitchell County, is located within the jurisdiction of the West Central Texas Council of Governments.

The town gently slopes to the south and drains into the Colorado River to the southwest and into Lone Wolf Creek to the southeast.

The City is predominantly underlain by soils of the Cobb-Miles type. These soils characteristically have a very friable, fine, sandy, loam surface, 6-10 inches thick over a weak, prismatic, subangular, blocky, friable, sandy, clay loam. There is weakly to strongly-cemented sandstone 30 to 40 inches beneath the surface. Permeabilities range from 2.0 to 6.3 inches per hour. Sewage lagoons have moderate limitations due to the permeability and depth to bedrock.

Population data developed by the TWDB for use in this study indicate that a substantial decrease in population is expected for Colorado City over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 5,227 | 4,630 | 4,150 | 2,720 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with some industrial contribution from clothing and carpet pad manufacturing plants. The City is also an electric service center. Accessible by Interstate 20, the City is served by the Texas and Pacific Railroad. Population growth is not anticipated for Colorado City due to the lack of adequate economic activity or resource availability.

The municipal water supply is solely drawn from Lake Colorado City by three pumps--two with capacities of 700 gpm each and one with a capacity of 3,000 gpm. Storage is provided by two clearwell reservoirs with capacities of 1.0 mg and 0.5 mg, and one elevated standpipe reservoir with a 0.25 mg capacity. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.84 | 0.80 | 0.75 | 0.53 |
| Industrial Use: | 0.03 | 0.03 | 0.03 | 0.04 |

*Flows in mgd:

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.44 | 0.39 | 0.35 | 0.23 |
| BOD in lb./day: | 890 | 830 | 750 | 520 |
| TSS in lb./day: | 1,040 | 970 | 910 | 630 |

The existing sewage collection system is shown on Plate WCT-7. An analysis of the sewer mains and the 12-inch outfall line indicates the existing system is at or near capacity under existing peak flow conditions. The system serves essentially all of the significantly developed areas of town, with only a small percentage of the dwellings using private septic tanks. Two areas which rely on septic tanks are the small subdivision in the northwest corner of the City and the small area south of College Avenue and north of the railroad tracks in the southeastern part

of the City. Both of these areas have only scattered occupied dwellings, and no plans have been made to abandon the septic tanks and extend sewer service to these areas.

The existing sewage treatment plant is 27 years old and is located in the southern sector of town near the intersection of East Central Avenue and Washington Street as shown on Plate WCT-7. The plant utilizes a rectangular clarifier with a mechanical scraper and skimmer for primary treatment, a single-stage trickling filter followed by another rectangular clarifier for secondary treatment, and irrigation of all effluent for final disposal. Specifically, sewage from the portion of the City north of the Colorado River flows through a manually-cleaned basket screen into the pump station wet well. The basket screen and the standby pump were recently installed to alleviate the problem of bypassing raw sewage to the Colorado River during breakdowns of the lift station which were often caused by large articles in the raw sewage plugging or jamming the pump. From the pump station, sewage flows through a 10-inch force main into the 12-inch outfall line which flows through a manually-cleaned bar screen into the wet well of the plant lift station. It is then pumped into the primary clarifier from which the effluent passes through the trickling filter to the final clarifier.

The effluent from the final clarifier flows into the single oxidation pond from which a nearby farmer pumps the effluent to his irrigation holding ponds. No chlorination of the final effluent is currently performed. Recirculation within the plant is from the bottom of the trickling filter to the lift station wet well. Sludge from both clarifiers is pumped to an anaerobic digestor from which digested sludge is periodically drained to sludge drying beds and ultimately disposed in a landfill. Supernatant from the digestor is returned to the lift station wet well. An emergency bypass line traverses to an emergency holding pond with a suction line available to pump the bypassed sewage back to the lift station wet well.

The design capacity of the plant is 0.513 mgd. It is estimated that the plant serves a population of about 5,000 and reportedly receives an average flow of approximately 0.35 mgd. The City has a no-discharge permit with monthly average flow and BOD allowed by the TWQB to be 0.35 mgd and 35 ppm respectively, with no restrictions on TSS. Available sampling data published by the Texas State Department of Health and Texas Water Quality Board are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (4/72) | TWQB (2/71) |
|---|---|---|
| Final BOD | 15 | 35 |
| Final TSS | 50 | 58 |

Generally, the operation and maintenance of the plant has been good. The existing site covers about 5 acres with little vacant area available for expansion. There are about 160 acres of land available for irrigation of effluent by the landowner, but only about 100 acres are presently irrigated. The landowner has three holding ponds with unknown capacities; however, reportedly no discharge is allowed to occur. Irrigation is performed through movable sprinkler pipe.

The water treatment plant is located about 0.3 mile north-northwest of the intersection of S.H. 163 and F.M. 1983. Wastewater produced by the plant, consisting of filter backwash water and chemical wastes, is discharged into four earthern tanks for reuse by an adjacent farmer. No discharge to a stream is allowed to occur.

There is no significant industrial or agricultural waste produced within the corporate limits of Colorado City nor is any such waste anticipated in the future. However, the Colorado Sand and Gravel Company, located about 0.5 mile south of the City, discharges some washwater into the Colorado River with some sedimentation resulting in the river bed. Also, the Texas Electric Service Company has a power plant located about 4 miles southwest of the City on the east side of Lake Colorado City. The power plant draws cooling water from the lake and returns it to the lake with only some minor thermal effect and without apparent significant pollution of the lake.

The existing collection system is adequate to carry existing flows and serves essentially all of the significant development in the area; thus, no extensions or relief lines are recommended. Since the population is projected to decline, no new service mains are recommended. With only minor extensions and expansions as needed, the system should serve the needs of the declining population.

The existing sewage treatment plant is 27 years old and appears to have been fairly well operated and maintained. An engineering report on the

sewage treatment plant prepared in 1969 stated the existing facility was worn out and incapable of meeting its discharge requirements. The report recommended that a new facility be constructed; however, since that time the City has begun to irrigate all effluent and ceased discharging to the Colorado River. This action has made treatment levels obtained by the existing plant acceptable to the TWQB. Therefore, a new sewage treatment was never built, nor are there any current plans for such construction.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. The existing treatment plant with irrigation of all effluent in accordance with acceptable standards will satisfy the requirements of the law, providing that the plant can be maintained in an operating condition which is satisfactory to the TWQB. In light of the projected population decrease, it is anticipated that regular maintenance and any major overhaul that may be required would be more economical than construction of a new plant. It is therefore recommended that such improvements be made on an as-needed basis.

The proposed wastewater disposal system has and will continue to eliminate any adverse effects that may be associated with a discharge into the River. Currently, effluent is being used to irrigate alfalfa and some native grasses with some very good crops resulting therefrom. Implementation of total irrigation has greatly assisted in the enhancement of water quality in the Colorado River immediately below Colorado City, as well as having a positive effect on the local economy.

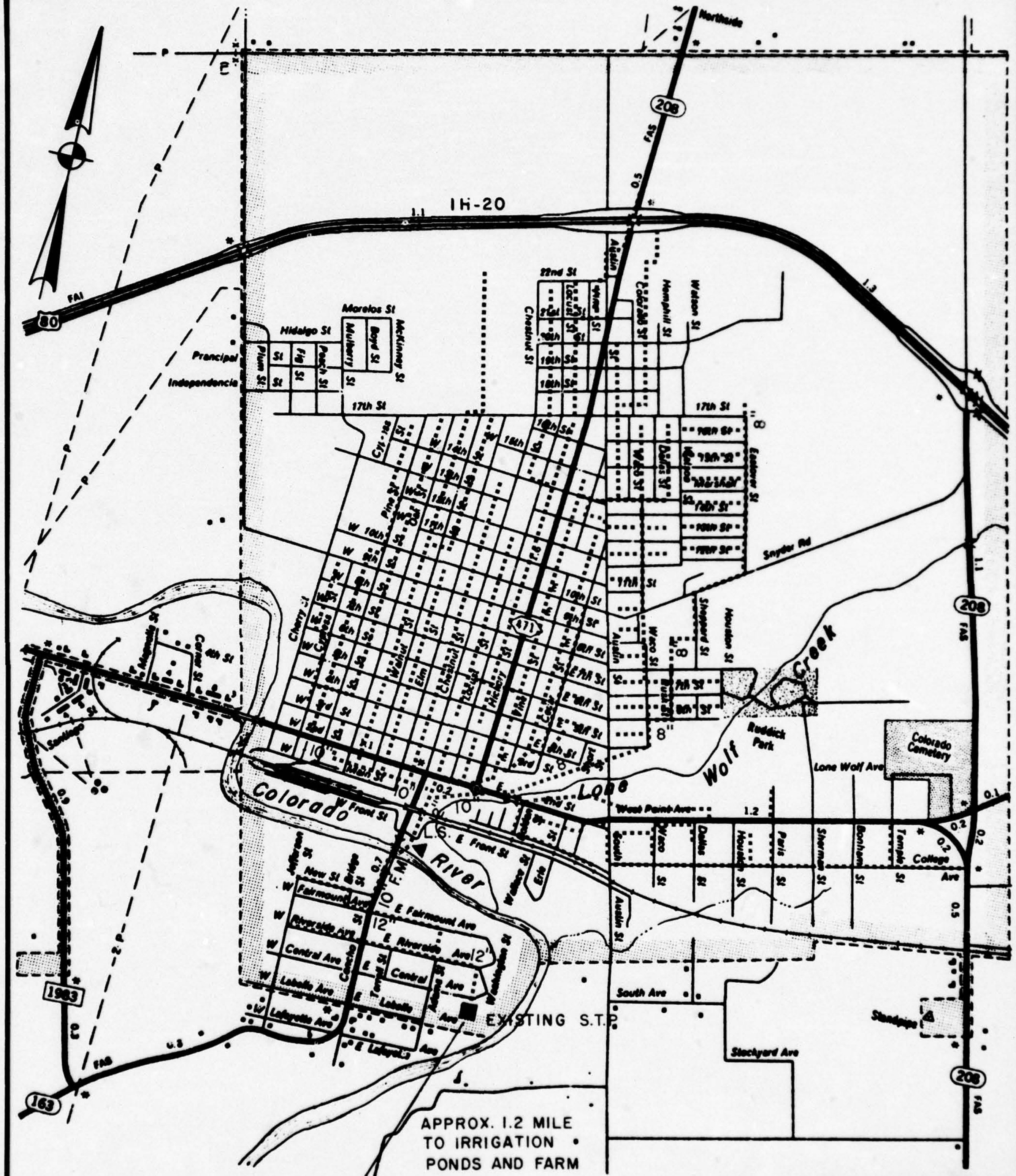
In conclusion, the most practical and economical way to meet the requirements of PL 92-500 is to continue to irrigate all effluent from the existing plant as recommended herein. The City should continue to perform regular maintenance and necessary overhaul of treatment units in order to keep the existing plant in satisfactory operating condition. It is recommended the City formalize its contractual agreement with the local farmers to insure year-round irrigation and that no discharge of pollutants is made to the Colorado River.

It is recommended that the aforementioned no-discharge plan be continued. However, should the City of Colorado City wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility of contact-stabilization type at an approximate capital cost of $334,900, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $172,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $137,000, including engineering and contingencies.




## LEGEND

.......... EXISTING SEWER LINE

— — — PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

## COLORADO CITY, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE: WCT-7

AREAWIDE PLAN
FOR
LORAINE, TEXAS

The City of Loraine is an incorporated, general law municipality located in the northeastern portion of Mitchell County at the intersection of Interstate Highway 20 and F.M. 644, approximately 45 miles east of Big Spring, Texas. The incorporated area encompasses approximately 600 acres and is located within the jurisdiction of the West Central Texas Council of Governments.

The City gently slopes to the north-northeast and drains into a tributary of the North Fork of Champion Creek.

The City is predominantly underlain by soils of the Cobb-Miles type. The soil has a very friable, fine, sandy, loam surface, 6-10 inches thick over a weak, prismatic, subangular, blocky, friable, sandy clay loam. There is weakly to strongly cemented sandstone 30 to 40 inches beneath the surface. Permeabilities range from 2.0 to 6.3 inches per hour. Septic tanks and sewage lagoons both have moderate limitations due to the depth of bedrock and the permeability, respectively.

Population data developed by the TWDB for use in this study indicate that a rapid decrease in population is expected for Loraine over the next fifty years. The population projections are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 700 | 570 | 480 | 250 |

Land use of the City, typical of that of other small towns, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with no significant industrial contribution. Accessible by Interstate 20, Loraine is served by the Texas and Pacific Railroad.

The municipal water supply consists solely of ground water drawn by four wells with capacities of 60, 70, 100, and 180 gpm. Storage is

provided by two ground reservoirs with capacities of 0.055 mg and 0.10 mg and by one elevated reservoir with a 0.05 mg capacity. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.05 | 0.04 | 0.04 | 0.02 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.06 | 0.05 | 0.04 | 0.02 |
| BOD in lb./day: | 120 | 100 | 86 | 48 |
| TSS in lb./day: | 140 | 120 | 110 | 58 |

The existing sewage collection system is shown on Plate WCT-8. An analysis of the sewer mains and 8-inch outfall line indicates that they have adequate capacity to carry existing flows. The system serves essentially all significantly developed areas with only a few scattered dwellings utilizing private septic tanks.

The existing sewage treatment plant is 45 years old and is located approximately 1.0 mile northwest of the City as shown on Plate WCT-8. The plant utilizes a rectangular Imhoff tank for primary treatment, and until recently a sand trickling filter was utilized for secondary treatment.

Construction is in progress on two oxidation ponds which will be utilized in series to provide secondary treatment in lieu of the old filter. Also, a new sludge drying bed is being constructed to replace the old sludge pit.

Presently, raw sewage first passes through a manually-cleaned bar screen into the Imhoff tank. During construction, effluent from the Imhoff tank flows by way of a bypass ditch into the North Fork of Champion Creek. However, once construction is completed, the effluent from the Imhoff tank will flow by gravity through the two oxidation ponds in series before entering the creek. Sludge will be drained from the Imhoff tank periodically into the new sludge drying bed when construction is completed, but for the present it is drained into the old sludge pit. The dried sludge is disposed of as landfill.

The design capacity of the improved plant is about 0.06 mgd. It is estimated that the plant serves a population of about 700 and reportedly receives an average flow of approximately 0.04 mgd. The monthly average discharge, BOD and TSS permitted by the TWQB are 0.250 mgd, 20 ppm, and 35 ppm, respectively. It is anticipated that the new oxidation ponds should improve the effluent BOD to between 30-40 ppm with proper operation and maintenance. However, the final TSS will probably run anywhere from 50-100 ppm, depending on the rate of growth of algae in the ponds.

Generally, the existing plant is old and has not been satisfactorily operated and maintained. However, the plant improvements which are presently under construction should eliminate some of the maintenance problems. The existing site occupies about 6 acres, of which about 3 acres are available for expansion. Essentially, all of the effluent is discharged to the North Fork of Champion Creek. However, during the summer months a landowner pumps water from behind a small dam located approximately one mile downstream from the plant and utilizes it to irrigate approximately 10 acres of sudan grass or alfalfa. Also, an adjacent landowner to the east of the plant has on a few occasions pumped effluent from the Imhoff tank onto his land, but he has not done so recently nor were the amounts very significant.

Since the City utilizes wells for their municipal water supply and the City does not have a water treatment plant, there are no water treatment plant wastes produced in the area. There are no significant industrial or agricultural wastes produced within the corporate limits of Loraine or in the immediate vicinity, nor are any such wastes anticipated for this area in the future.

The existing system is adequate to carry existing flows and serves essentially all of the significant development in the area; thus, no extensions or relief lines are recommended. Since the population is projected to decline, no new service mains are recommended; and with only minor extensions and expansions, as needed, the system should serve the needs of the declining population.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by the existing sewage treatment plant, even with the improvements which are currently under construction. In lieu of constructing costly conventional secondary treatment facilities in order to meet the 1977 requirements of the law, it is recommended that the effluent from the plant be used entirely for irrigation of farmland so that no discharge to the creek occurs. It is recommended the City enter into a contractual agreement with a landowner for the irrigation of all effluent from the plant, with the landowner supplying the necessary pumpage, irrigation equipment, and holding ponds which may be necessary to store the effluent during non-irrigable periods. It should be noted that the City has the alternative of owning and operating its own irrigation system, which would require the City to acquire the necessary land and irrigation facilities. The estimated cost, including a 92.2-acre holding pond, irrigation equipment, 12 acres of land and engineering and contingencies for such facilities is $61,000. The additional annual operation and maintenance costs are estimated to be $9,000.

In order to meet the requirements of PL 92-500 that the best practicable treatment be utilized by 1983, it is recommended that all effluent continue to be irrigated so that no discharge of pollutants to the creek occurs.

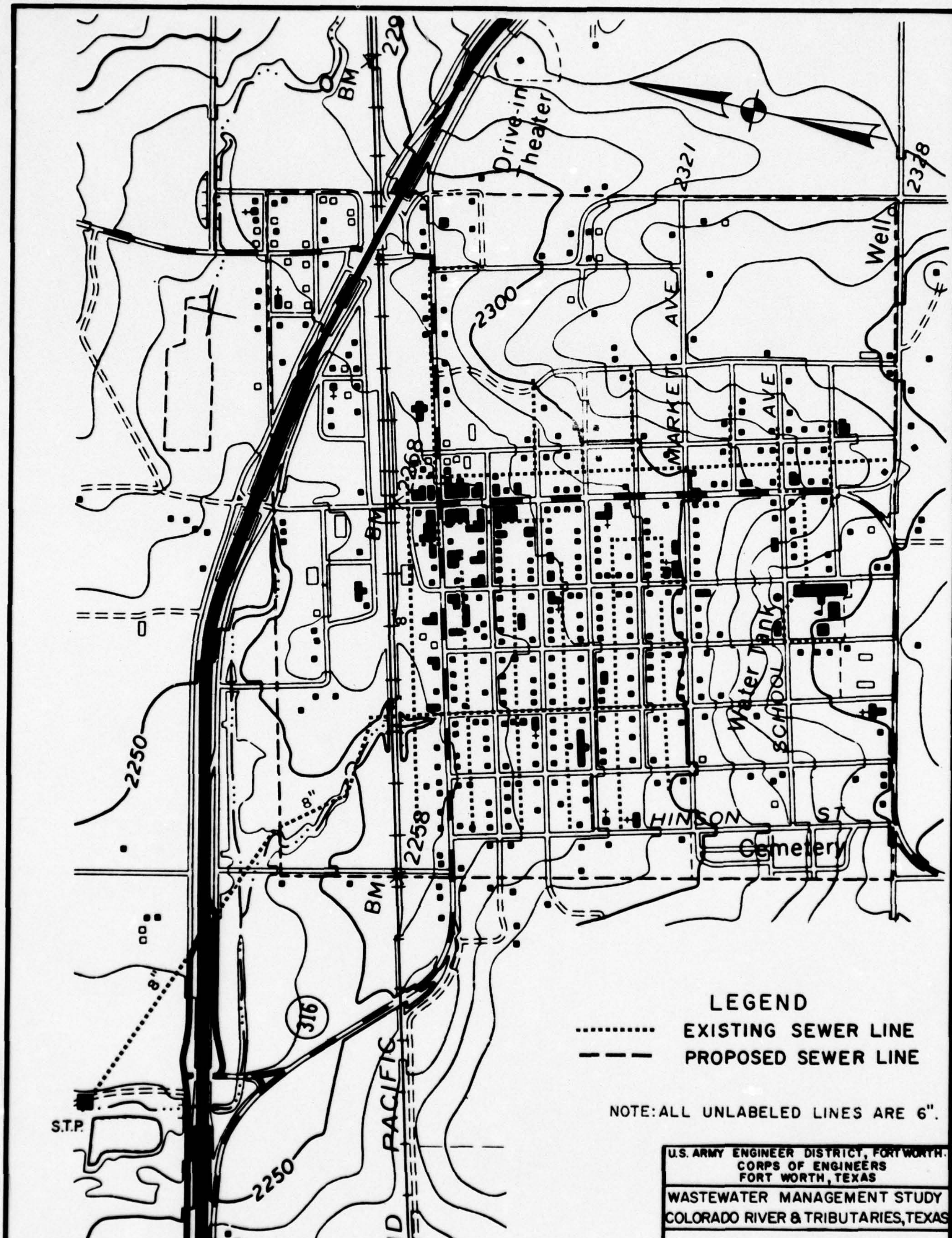
In conclusion, the most practical and economical way to meet the requirements of the law would be to irrigate all effluent; therefore, this method is recommended. The recommended plan of irrigation with all effluent from the plant will eliminate any adverse effects on the receiving watercourse that may have been associated with an effluent discharge. Irrigation with effluent will provide for a most valuable reuse of treated wastewater in a seasonally semi-arid area. In addition to making it unnecessary to discharge effluent to the creek, the irrigation of the effluent will make it possible to produce quality crops of grasses and small grains from the irrigated land.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Loraine wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $193,100, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $76,800, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $61,000, including engineering and contingencies.


Drive-in Theater
2321
2328
Well
2300
MARKET AVE
AVE
Water Tank
SCHOOL
HINSON ST
Cemetery
2268
2258
2250
BM
8"
316
PACIFIC
AND
S.T.P.
2250
LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: ALL UNLABELED LINES ARE 6".
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LORAINE, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'
PLATE: WCT-8

## AREAWIDE PLAN
## FOR
## BALLINGER, TEXAS

The City of Ballinger, an incorporated, home-rule municipality, is located in the central portion of Runnels County at the intersection of U.S. Highways 67 and 83, approximately 35 miles northeast of San Angelo, Texas. The incorporated area encompasses 1,670 acres. Ballinger, the county seat of Runnels County, is located within the jurisdiction of the West Central Texas Council of Government.

The City is bounded by the Colorado River on the south and by Elm Creek on the northeast. The topography is gently sloping with approximately two-thirds of the drainage to the Colorado River and one-third of the drainage to Elm Creek, a tributary of the Colorado River.

The northwestern portion of the City is underlain by Mereta-Potter clay loams. These soils have a friable, calcareous surface, 8-12 inches thick, over friable, granular, strongly calcareous, silty clay or clay loam. There is a hard rock-like caliche layer at 15-35 inches. Surface permeabilities range from 0.20 to 0.63 inch per hour. There are severe limitations on septic tanks and sewage lagoons due to the shallow caliche layer.

The southern and central portions of Ballinger are underlain by Norwood-Wichita soils. These types have a friable, strongly calcareous, silt loam to silty clay loam surface, 9-25 inches thick, over friable, granular, silt loam or silty, clay loam. Surface permeabilities range from 0.63 to 2.0 inches per hour. Septic tanks have slight to severe limitations due to flooding, and sewage lagoons have moderate limitation due to the soil's permeability.

Population data developed by the TWDB for use in this study indicate that a decrease in population is expected for Ballinger over the next fifty years. The population projections are as follows:

**Population Projections**

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 4,230 | 4,050 | 3,850 | 3,110 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity. The City has meat and metal processing plants, a small oil field construction company, a garment plant, and a telephone equipment rebuilding plant. Ballinger also has a library and a hospital. Accessible by two U.S. highways, the City is served by the Atchison, Topeka, and Santa Fe Railroad and a municipal airport.

The municipal water supply is obtained solely from Lake Ballinger by two pumps with 700 gpm and 1,400 gpm capacities. Storage is provided by two elevated reservoirs with capacities of 0.25 mg each and by a clear well reservoir with a 0.20 mg capacity. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.66 | 0.69 | 0.68 | 0.59 |
| Industrial Use: | 0.02 | 0.02 | 0.02 | 0.03 |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd: | 0.36 | 0.34 | 0.33 | 0.26 |
| BOD in lb./day: | 710 | 730 | 690 | 590 |
| TSS in lb./day: | 840 | 850 | 850 | 710 |

These municipal waste load projections are in addition to the contributions from the local meat processing plant which occasionally discharges to the treatment facility. This loading, which is anticipated to remain constant throughout the planning period, has been estimated to be about 0.03 mgd with BOD and TSS loadings of 60 lbs. per day each.

The existing sewage collection system is illustrated on Plate WCT-9. An analysis of the sewer mains indicates that they have sufficient capacity to carry the existing flows. The collection system serves nearly all of the significantly developed areas of Ballinger, with the exceptions of some of the development in the northwest sector to town near S. H. 158 and F. M. 2887 and the development south of the Colorado River near U.S. Highway 67 where private septic tanks are used.

The existing sewage treatment plant is 25 years old and is located in the southeast sector of Ballinger near the confluence of Elm Creek with the Colorado River as shown on Plate WCT-9. The plant utilizes a rectangular Imhoff tank for primary treatment followed by a trickling filter for secondary treatment. Specifically, raw sewage flows into the lift station wet well and is then pumped through a bar screen and grit channel. The sewage then flows into the Imhoff tank from which it flows by gravity to the trickling filter dosing tank and subsequently through the trickling filter. The effluent from the trickling filter flows into a 1.3-acre oxidation pond. The overflow from the oxidation pond is discharged to Elm Creek without benefit of chlorination. Although irrigation with municipal effluent is common to this area, no reuse of treatment plant effluent for irrigation has been practiced at Ballinger even though there is irrigable land in this area. A recirculation pump draws from the oxidation pond and discharges at the head of the plant. Sludge is periodically drained from the Imhoff tank to the sludge drying beds. The dried sludge is then disposed of in a landfill.

The design capacity of the plant is 0.28 mgd. It is estimated that the plant serves a population of about 4,000 and reportedly receives an average flow of approximately 0.22 mgd. The monthly average flow, BOD and TSS levels allowed by the TWQB are 0.28 mgd, 20 ppm and 125 ppm, respectively. Available sampling data published by the TSDH and TWQB is as follows:

**Influent - Effluent Data (mg/l)**

| | TSDH (5/72) | TWQB (11/71) |
|---|---|---|
| Raw BOD | 70 | 270 |
| Raw TSS | 90 | 176 |
| Final BOD | 15 | 20 |
| Final TSS | 31 | 50 |

Generally, the plant is fairly well operated and maintained. The existing site covers about 3.5 acres, with little vacant area available for expansion.

The City owns and operates a water treatment plant which is located in the west-central sector of Ballinger on Country Club Road. The wastewater from the plant consists of treatment chemicals, sediments, and backwash water. This wastewater is discharged to a pasture area.

The only industrial waste which is treated by the municipal sewage treatment plant is the occasional discharge, normally less than 30,000 gpd, from a meat processing plant. The City has an industrial waste ordinance which limits these wastes to less than 250 ppm of BOD and TSS. Normally, the treatment plant is not adversely affected by the process water, but occasionally a significant discharge of high BOD waste reaches the plant and upsets the operation. No other significant industrial or agricultural wastes are produced in this area nor are any anticipated in the future.

The existing wastewater collection system is adequate to carry present flows and serves nearly all of the significant development in the area. It is recommended that sanitary sewer service be extended to the development in the northwest sector of the City along S.H. 158 and F.M. 2887 and to the development south of the Colorado River along U.S. 67. These extensions of service are illustrated on Plate WCT-9. It is estimated the extensions will cost approximately $206,000, including engineering and contingencies. The additional operation and maintenance expenses are estimated to be $4,100 annually. Since the population is projected to decline, no new service lines to presently unpopulated areas

are recommended, and, with only minor extensions or expansions as needed, the system should serve the needs of the declining population.

The existing sewage treatment plant is 25 years old and appears to have been fairly well operated and maintained. Although the sampling data presented earlier are within the limitations imposed by the TWQB, the data do not appear representative of what the system would be capable of producing. The treatment plant has been subject to recent inquiry by the TWQB as a result of discharges exceeding the limitations of the permit. At the Board's request, the City engaged their consultant to make an engineering study of the sewage treatment facility and followed their recommendations with an application for a Federal grant to make the necessary improvements to the plant. These improvements to the existing plant include renovation of the existing trickling filter and oxidation pond, an addition of a preaeration facility at the head of the plant, a final clarifier, chlorination facilities, and a new recycle pump.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by a trickling filter process such as employed by the City. It is also questionable at the present time whether the facility will be capable of meeting the secondary treatment requirements even after the planned modifications are made. It is suggested that the City discuss with technical representatives of the TWQB and EPA whether the planned improvements will place the City in compliance with the requirements of the law.

In addition to the planned improvements described above, it is recommended that the oxidation pond be subdivided into two ponds with one pond reserved for emergency or wet-weather flow storage. It is also suggested that the effluent from the chlorine contact tank be discharged to Elm Creek, unless it is found that placing the effluent in one of the oxidation ponds prior to discharge into the creek would provide additional improvement to the effluent quality. It should be noted that similar installations of ponds to follow secondary facilities as "polishing ponds" have lowered the quality of the effluent due to the algae growth in the ponds. The total cost to implement the planned improvements by 1977 has been estimated at $198,000 including engineering and contingencies, with annual operation and maintenance of the improved plant estimated to be $28,000.

Should the planned improvements prove incapable of meeting the requirements of PL 92-500, it is recommended that all the effluent be utilized for farmland irrigation by 1977 such that no discharge occurs to Elm Creek. Most financially attractive to the City would be contractual agreement with individual landowners who would utilize effluent for irrigation on a year-round basis with the landowners providing the necessary facilities for pumping, storage, and application. The alternative to this agreement would be for the City to own and operate the system. The estimated capital cost to implement this alternative by 1977 is $182,000. This cost includes a 13 acre holding pond, irrigation equipment, 56 acres of land, and engineering and contingencies. Annual operation and maintenance costs for this alternative are estimated to be $15,000.

Therefore, it is recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Ballinger wish to implement a discharge plan, the following items would be required:

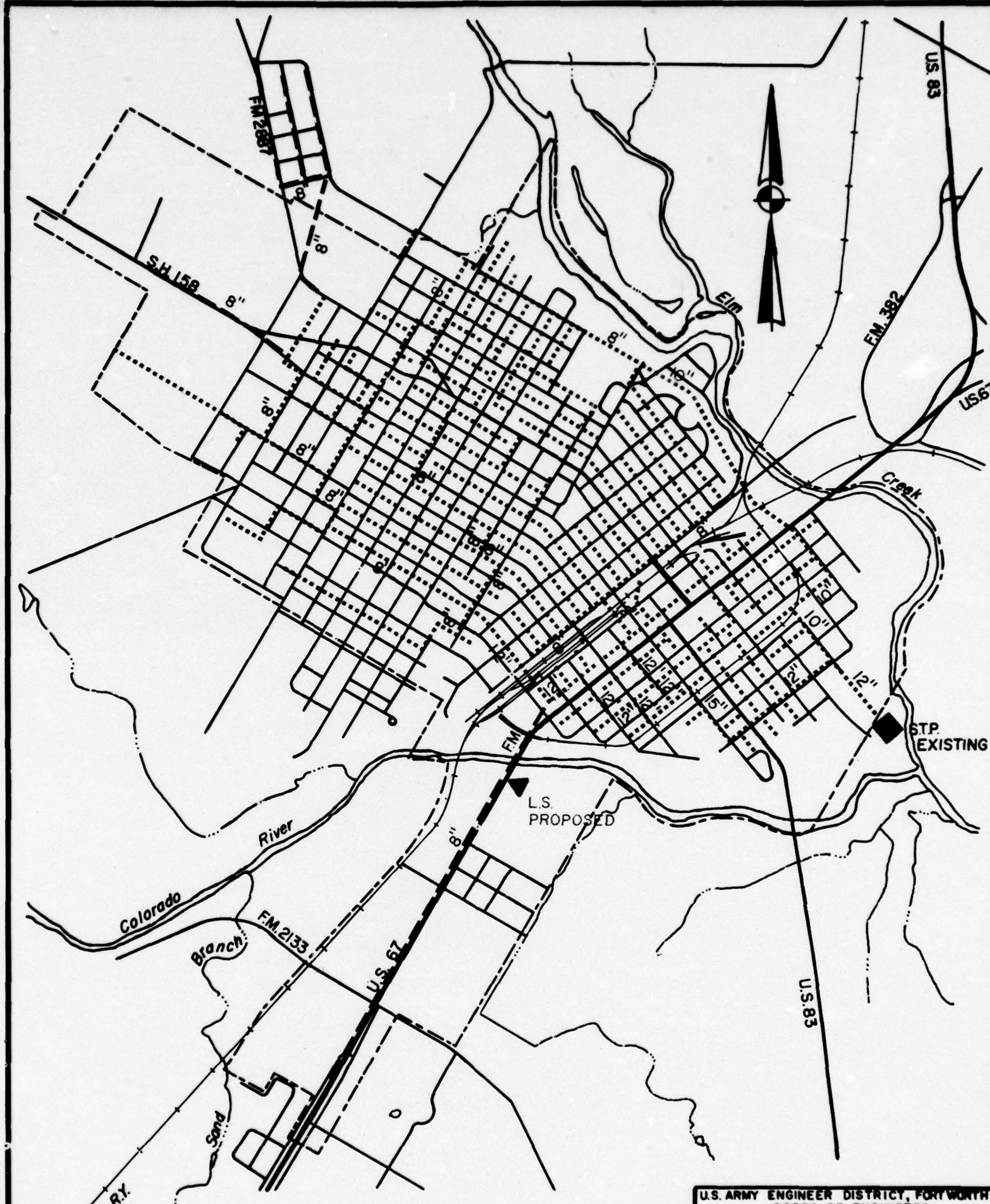
1. An alternative to improving the existing plant would be to construct a new activated-sludge plant operated in the contact-stabilization mode in order to meet the 1977 requirements. The cost of this new plant is estimated to be $360,000 including engineering and contingencies with annual operation and maintenance estimated to be $25,000.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $145,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $130,000, including engineering and contingencies.

Environmentally, many of the previously proposed improvements would reduce any existing adverse effects on Elm Creek. Total irrigation would eliminate discharge of plant effluent to the stream and would provide a

most valuable and economical reuse of a valuable resource in a semi-arid area. In addition to eliminating discharge of treated wastewater to a receiving stream, irrigation of effluent will make it possible to produce quality crops of grasses and small grains from the land to which it is applied.




LEGEND

EXISTING SEWER LINE

PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BALLINGER, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE: WCT-9

AREAWIDE PLAN
FOR
MILES, TEXAS

The City of Miles is an incorporated, general law municipality situated in the southwestern corner of Runnels County at the intersection of U.S. Highway 67 and F.M. 1692, approximately 15 miles northeast of San Angelo, Texas. The incorporated area encompasses approximately 930 acres and lies within the jurisdiction of the West Central Texas Council of Governments.

The topographic relief of the City is slight, with the land gently sloping generally to the southeast. Bottle Creek, a tributary of Willow Creek which drains into the Concho River, flows through the central portion of Miles.

The City is predominantly underlain by soils of the Abilene-Roscoe type. This soil has a friable, neutral to alkaline, clay loam to loam surface, 6 to 10 inches thick, over a friable, subangular, blocky, calcareous, clay. There is soft caliche at depths of 35-45 inches beneath the surface. Permeabilities are less than 0.06 inch per hour; consequently, septic tanks have severe limitations, but sewage lagoons have only slight limitations on 0-2 percent slopes and moderate limitations on 2-3 percent slopes.

Population data developed by the TWDB for use in this study indicate that a rapid decrease in population is expected for Miles over the next fifty years. The population projection is as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 631 | 530 | 410 | 170 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some industrial contribution from local gravel pit operations. Accessible by a U.S. highway, Miles is served by the

Atchison, Topeka, and Santa Fe Railroad. Population growth is not anticipated due to a lack of adequate economic activity or developable natural resources.

The municipal water supply, obtained solely from ground water sources, is drawn from three wells with pumping capacities of 85, 100, and 100 gpm. The water is stored in one elevated storage reservoir with a capacity of 0.055 mg. The projected water use, a reflection of the population trend, has been anticipated by the TWDB to be as follows:

Water Use Projections*

| | Year 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Municipal Use: | 0.05 | 0.05 | 0.03 | 0.02 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| | Year 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Flows in mgd: | 0.05 | 0.04 | 0.03 | 0.01 |
| BOD in lb./day: | 110 | 95 | 74 | 32 |
| TSS in lb./day: | 130 | 110 | 90 | 39 |

The existing sewage collection system is illustrated on Plate WCT-10. An analysis of the sewer mains and 10-inch outfall line indicate the existing system has adequate capacity to carry the existing flows. The system serves essentially all significantly developed areas with only a few scattered dwellings utilizing septic tanks.

The existing sewage treatment plant is seven years old and is located in the southeast corner of the City as shown on Plate WCT-10. The plant utilizes a rectangular Imhoff tank for primary treatment followed by a 2.2-acre oxidation pond for secondary treatment. Specifically, sewage first passes through a manually-cleaned bar screen and grit channel and flows into the Imhoff tank. Effluent from the Imhoff tank flows by gravity into the oxidation pond and thence is discharged into Bottle Creek. No chlorination of effluent prior to discharge is currently practiced. Sludge from the Imhoff tank is periodically wasted into sludge drying beds, and the dried sludge is disposed in a landfill.

The design capacity of the plant is 0.08 mgd. It is estimated the plant serves a population of about 600 and receives an average flow of about 0.04 mgd. The current monthly average discharge, BOD and TSS permitted by the TWQB are 0.08 mgd, 20 ppm, 20ppm, respective. Available sampling data published by the TSDH and TWQB are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (3/72) | TWQB (6/69) |
|---|---|---|
| Raw BOD | | 320 |
| Raw TSS | | 105 |
| Final BOD | 35 | 35 |
| Final TSS | 38 | 388 |

Generally, the plant is fairly well operated and maintained. The existing site covers 9.5 acres, of which about 5 acres are available for expansion. All of the treated wastewater is discharged into Bottle Creek with no irrigation of effluent currently practiced.

Since the City of Miles obtains its water supply from wells, there are no water treatment plant wastes produced in the area. There are no significant industrial or agricultural wastes produced within the corporate limits of Miles nor are any anticipated in the future. However, a 12,000-head cattle feedlot which is located about 2.5 miles southwest of Miles and adjacent to U.S. Highway 67 to the north has a permit to dispose of runoff from the feedlot in retention ponds having a capacity of 35

acre-feet. The ponds are dewatered by evaporation and irrigation of at least 175 acres of farmland. Solid wastes are utilized as a soil amendment and fertilizer by local farmers. No discharge from the holding facility is permitted by the TWQB except during occasions of rainfall in excess of 6.5 inches in a 24-hour period, at which time discharge may be made to a tributary of the Concho River.

The existing collection system is adequate to carry present flows and serves essentially all of the significant development in the area; thus, no extensions or relief lines are recommended. Since the population in 1960 and 1970 was essentially the same, with only minor extensions and expansions as needed, the system should serve the needs of the declining population.

The existing sewage treatment plant is seven years old and appears to have been fairly well operated and maintained. However, under the requirements of PL 92-500, publicly-owned works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by a treatment process such as employed by Miles, and the City will be required to implement a higher level of waste treatment prior to 1977. In lieu of constructing costly conventional secondary treatment facilities which the City could not afford to purchase or operate, and in order to be in compliance with the law, it is recommended that the effluent be used entirely for irrigation of farmland by 1977 such that no discharge to the creek occurs. The City currently has plans to construct a permanent 3.0-acre spray irrigation field to the east of the oxidation pond at an estimated cost for materials of $2,100. It is recommended that by 1977 the City should implement these plans and also modify the existing oxidation pond by separating it with a levee into a 1.5-acre oxidation pond and a 2.0-acre emergency and wet-weather holding pond, which will require a 1.3-acre expansion of the existing pond. The oxidation pond modification is estimated to cost about $6,000. It is estimated that operation and maintenance of the irrigation facility will be less than $3,000 annually, assuming that no additional personnel will be needed to operate it.

In lieu of constructing costly tertiary treatment facilities in order to meet the requirements of the law that the best practicable waste treatment technology be utilized by 1983, it is recommended that all effluent continue to be irrigated such that no discharge to Bottle Creek occurs.

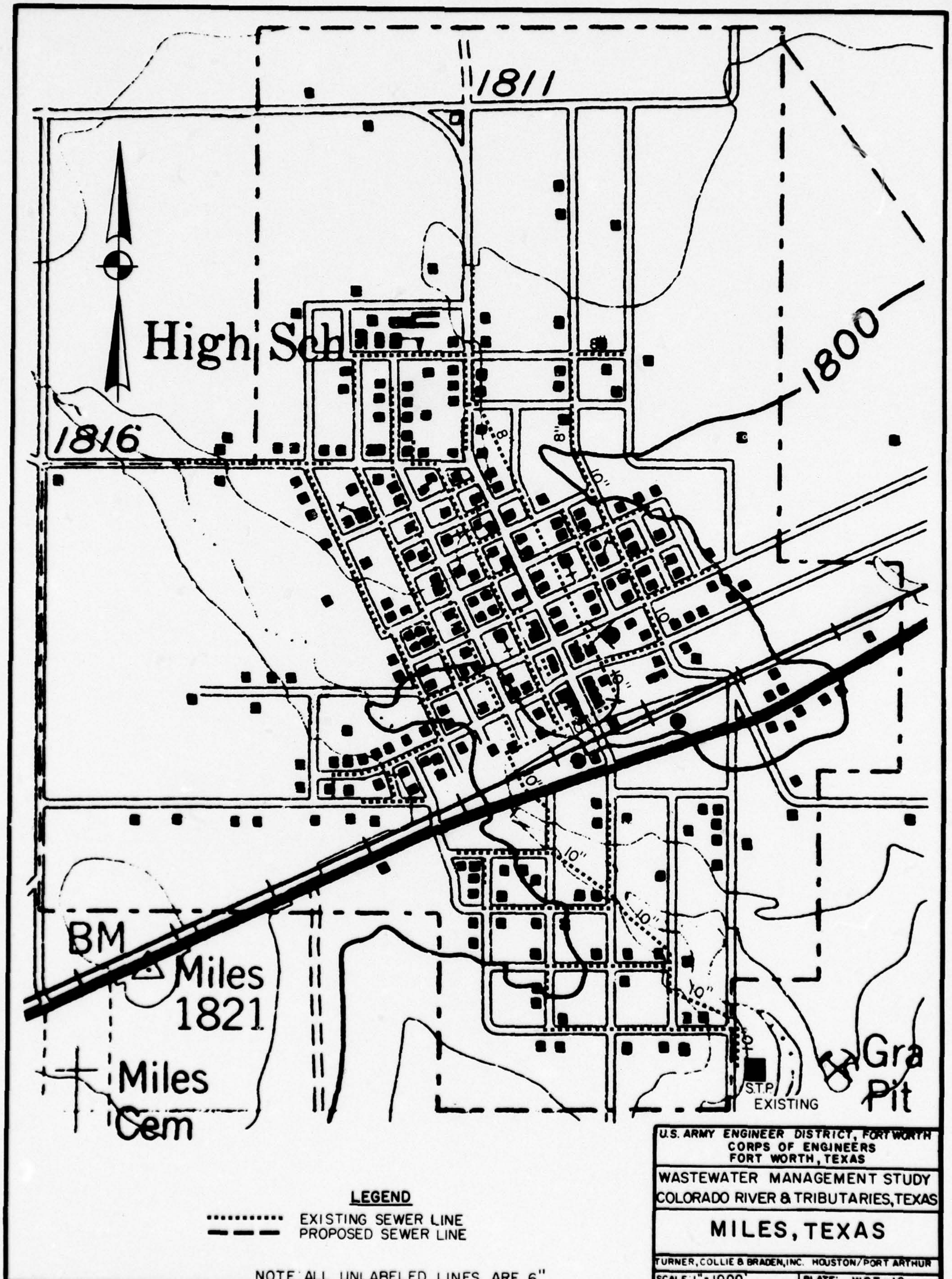
Disposal of treated domestic sewage by irrigation should have a positive economic effect on the area. Irrigation of the effluent will provide a valuable reuse of treated wastewater in a seasonally semi-arid area. In addition to eliminating any adverse effects associated with the present discharge of effluent to Bottle Creek, the irrigation should make it possible to produce quality crops of grasses from the irrigated land.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Miles wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $74,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,300, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $71,000, including engineering and contingencies.

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AREAWIDE PLAN
FOR
WINTERS, TEXAS

The City of Winters is an incorporated, general law municipality situated in the northcentral portion of Runnels County at the intersection of F.M. 53 and U.S. Highway 83 approximately 60 miles west of Brownwood, Texas. The incorporated area encompasses approximately 840 acres and lies within the jurisdiction of the West Central Texas Council of Governments.

The City slopes generally to the southeast with ground elevations fluctuating some forty feet. Bluff Creek to the east provides drainage for the City.

The City is underlain with soils of the Abilene-Mereta types. These soils have a friable, neutral to alkaline surface, 6 to 10 inches thick, over friable, subangular, blocky, noncalcareous, light clay that grades into firm, blocky, calcareous clay. There is soft caliche at depths of 35-45 inches beneath the surface. Permeabilities are less than 0.06 inch per hour, and consequently septic tanks have severe limitations.

Population data developed by the TWDB for use in this study indicate that a slight decrease in population is expected for Winters over the next fifty years. The population projections are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 2,907 | 2,900 | 2,800 | 2,390 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity and gravel mining. Industrial contribution is derived from gins, a feed mill, a grill and vent plant, a toolbox and truck rack plant, and a furniture plant. Accessible by a U.S. highway, the City is served by the Abilene and Southern Railroad.

The municipal water supply is obtained solely from Lake Winters by two pumps with capacities of 550 gpm each. Storage is provided by a clear well reservoir with a capacity of 0.025 mg, two ground reservoirs with capacities of 0.03 mg and 0.15 mg, and a 0.10-mg capacity elevated reservoir. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

**Water Use Projections***

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 0.37 | 0.39 | 0.38 | 0.34 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

**Waste Load Projections**

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd | 0.25 | 0.25 | 0.24 | 0.20 |
| BOD in lb./day: | 490 | 520 | 500 | 450 |
| TSS in lb./day: | 580 | 610 | 620 | 550 |

The existing sewage collection system is illustrated on Plate WCT-11. An analysis of the sewer mains and outfall line indicates that they have adequate capacity to carry the present flows. The system serves essentially all of the significantly developed areas of the City with the exception of a small area west of the City on Loop 43 and a small area south of the City near the junction of U.S. Highway 83 and F.M. 53 where a cluster of dwellings utilize private septic tanks.

The existing sewage treatment plant is 49 years old and is located southeast of the City as shown on Plate WCT-11. The plant utilizes an aerated Imhoff tank for primary treatment followed by two oxidation ponds in series for secondary treatment. Specifically, raw sewage flows into the aerated Imhoff tank and thence into the pump station wet well. Flow is then pumped to two oxidation ponds in series. The effluent from the oxidation ponds is utilized for irrigation of grasses and small grains. Sludge from the Imhoff tank is periodically drained into a sludge pit, and the dried sludge is deposited in a landfill. No pretreatment of raw sewage or chlorination of effluent is currently practiced.

The stated design capacity of this plant is 0.210 mgd. It is estimated that the plant serves a population of 2,700 and reportedly receives an average flow of 0.154 mgd. The monthly average flow, BOD and TSS permitted by the TWQB are 0.160 mgd, 55 ppm and 120 ppm, respectively. Available sampling data purlished by the TSDH and TWQB are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (10/71) | TWQB (10/71) |
|---|---|---|
| Raw BOD | 300 | 30 |
| Raw TSS | 370 | 37 |
| Final BOD | 9 | 9 |
| Final TSS | 22 | 22 |

Generally, the plant is in poor condition, and operation and maintenance have apparently been fair. Aeration of the Imhoff tank has apparently helped to reduce odors. According to a recently published report on the plant, the existing oxidation ponds have a surface area of 4.4 acres, which the report asserts is about 4 acres deficient of the area that would be required under presently-acceptable design criteria to treat present flows. As a result of some complaints from downstream property owners, inquiries and recommendations made by the TWQB, the City recently engaged a consultant to prepare a wastewater treatment study and has followed the recommendations with an application for a Federal grant to assist in the financing of the construction of a new sewage treatment facility.

At present, effluent from the oxidation ponds which is not used for irrigation is discharged to Bluff Creek. The irrigation system consists of open ditches which flood terraced areas by means of manually-valved outlets. The City currently leases its 122 acres of land to a farmer who generally operated the irrigation system and farms the land.

The City has a water treatment plant located in the southeast sector near Loop 438. The wastewater produced by the plant is primarily filter backwash water and spent lime sludge. The wastewater is discharged into an earthen pit from which the clarified water is used for irrigation or discharged to Bluff Creek.

There are no significant industrial or agricultural wastewaters produced within the corporate limits of Winters nor are any anticipated in the future. However, a 15,000-head cattle feedlot which is located about 2.5 miles northwest of Winters has a permit to dispose of runoff from the cattle feedlot in a 47 acre-foot retention pond. Solid wastes and effluent from the pond are disposed on 140 acres of adjacent farmland. No discharge is permitted by the TWQB except during occasions of rainfall in excess of 6 inches in a 24-hour period, at which time a discharge may be made to Big Coyote Creek.

The existing collection system is adequate to carry existing flows and serves nearly all significant development in the area. It is recommended that service be extended to the two areas near Loop 438 and near the junction of U.S. 83 and F.M. 53 as shown on Plate WCT-11. The estimated cost of these extensions, including engineering and contingencies, is $14,000. Also, a new 12-inch outfall line will be needed from F.M. 53 south to the proposed new plant site when the plant is constructed. The cost of this line has been included in the cost of the new plant. Since the population of Winters is projected to continue to decline through the next fifty years, no new service mains are recommended, and with only minor extensions and expansions as needed, the system should serve the needs of the declining population. The plant proposed by the City's consultant is an activated sludge facility operated in the extended aeration mode of a type known as a "race track" or oxidation ditch. The unit consists of a pretreatment unit, an oxidation ditch, clarifier, sludge drying beds, and a chlorination facility. This plant has been estimated to cost $208,000.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best

practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will be attainable by an activated sludge process as proposed for Winters. It is felt, however, that it is characteristic of the activated sludge process that the efficient operating range of the extended aeration mode is somewhat below the capacity needed by the City. It would therefore be recommended that the City consider an 0.25-mgd activated sludge plant, operated in the contact-stabilization mode, be constructed unless greater economies and benefits from a "race track" plant can be shown locally. The cost of the contact-stabilization plant is estimated to be $223,000, including engineering and contingencies, with annual operation and maintenance costs estimated to be $19,000.

In lieu of constructing costly tertiary facilities which the City could neither afford to purchase nor maintain, and in order to meet the requirements of the law that the best practicable treatment be utilized by 1983, it is recommended that all effluent be diverted to irrigation on a year-round basis such that no discharge into Bluff Creek occurs. It appears from preliminary calculations that the 122-acre tract should contain enough land to accommodate total irrigation; however, it is possible that some minor expansion and/or improvement of present irrigation and holding facilities may be required in the future.

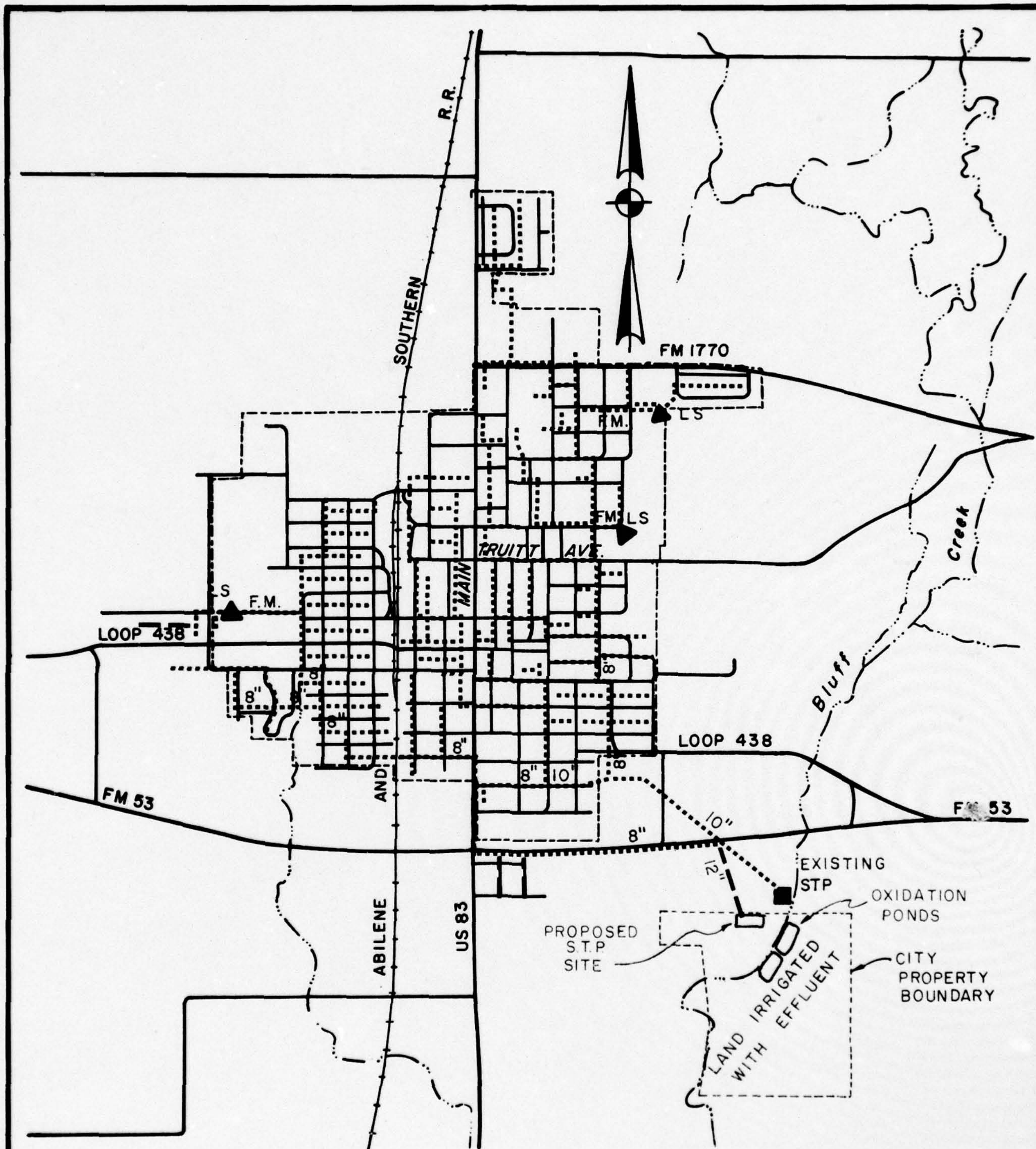
In conclusion, the most practical and economical method to meet the requirements of PL 92-500 would be to construct a new secondary treatment plant by 1977 and to irrigate all effluent by 1983 as recommended herein. Environmentally, such improvements to the City of Winter's existing wastewater system will have a positive effect. The new plant will alleviate any present adverse effects on the creek created by discharge of effluent from the inadequate existing plant. In addition to eliminating discharge of a properly treated secondary wastewater to the creek by 1983, irrigation of effluent will assist in producing quality crops of grasses and small grains from the irrigated land.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Winters wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $223,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $139,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $119,000, including engineering and contingencies.




**LEGEND**

- ............ EXISTING SEWER LINE
- — — — PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

**WINTERS, TEXAS**

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE: WCT-11

# AREAWIDE PLAN
# FOR
# SNYDER, TEXAS

The City of Snyder is an incorporated, home-rule city situated in the central portion of Scurry County at the intersection of U.S. Highways 180 and 84, approximately 45 miles northeast of Big Spring, Texas. The incorporated area of the City encompasses approximately 2,500 acres. Snyder, the county seat of Scurry County, is located within the jurisdiction of the West Central Texas Council of Governments.

The City is divided into eastern and western portions by Deep Creek, which flows from north to south. The eastern portion slopes to the southwest and the western portion to the southeast.

The central portion of the City is underlain by Cobb-Miles soils. These soils have a very friable, weak, granular, slightly acid, sandy loam, sand surface, 6 to 14 inches thick, over friable, compound, prismatic, and subangular, blocky, slightly acid, sandy clay loam to sandy loam. Surface permeabilities range from 0.8 to 2.5 inches per hour. There are severe limitations on septic tanks due to the shallow clays.

The Abilene-Mansker soils underlie the northern portion of the City. This soil type generally has a friable, neutral to alkaline, clay loam to loam surface, 6-10 inches thick, over friable, subangular, blocky, noncalcareous clay that grades into a firm, blocky, calcareous clay. There is soft caliche at depths of 35-45 inches beneath the surface. Surface permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks have severe limitations due to the slow permeability of the underlying caliche.

The southern portion of the City is underlain by Mansker-Potter soils. These soils generally have a friable, loam to clay loam surface, 6-12 inches thick, over friable, granular, clay loam with small calcium carbonate concretions throughout. Surface permeabilities range from 0.8 to 2.5 inches per hour. Septic tanks have moderate to severe limitations, depending on the absence or presence of a caliche underlayer.

Population data developed by the TWQB for use in this study indicate that a moderate decrease in population is expected for Snyder over the next fifty years. The population estimates are as follows:

Population Projections

| Year: | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|
| Population: | 11,170 | 10,630 | 9,970 | 7,780 |

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity. The industrial contribution to the economy is from a petroleum refinery, a brick manufacturing plant, a mattress manufacturing plant, a mobile home plant, a magnesium products plant, a wax processing plant, and a sewing factory. The County hospital and West Texas College are also located in Snyder.

Accessible by two U.S. highways, Snyder is served by the Atchison, Topeka, and Santa Fe Railroad, the Roscoe, Snyder, and Pacific Railroad, and a municipal airport.

The municipal water supply is obtained from ground water and surface water sources. Ground water is drawn by three wells with pumping capacities of 350 gpm each. Surface water from Lake J. B. Thomas is purchased from the Colorado River Municipal Water District. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Municipal Use: | 1.90 | 1.94 | 1.89 | 1.60 |
| Industrial Use: | None | None | None | None |

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

| | Year | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2020 |
| Flows in mgd | 0.95 | 0.90 | 0.85 | 0.66 |
| BOD in lb. /day: | 1,900 | 1,900 | 1,800 | 1,500 |
| TSS in lb. /day: | 2,200 | 2,200 | 2,200 | 1,800 |

The existing sewage collection system is illustrated on Plate WCT-12. The sewer mains and outfall lines appear to have adequate capacity to carry the present flows. The system serves nearly all of the significantly developed areas of the City, with only about 200 water customers not presently served by the sewer system. Many of the dwellings without sewer service are located in the lightly populated areas on the fringe of the City and are utilizing private septic tanks and cesspools. These private systems are apparently causing no difficulties and there are no present plans for abandonment.

The existing sewage treatment plant is 23 years old and is located in the southeastern sector of the City as shown on Plate WCT-12. The plant utilizes a circular clarifier for primary treatment and a trickling filter followed by another circular clarifier for secondary treatment. Specifically, raw sewage passes through a mechanically-cleaned bar screen and grit channel into the lift station wet well. Thence, the sewage is pumped to the primary clarifier from which the effluent flows by gravity through the trickling filter and into the final clarifier. Sludge is recirculated from the bottom of the final clarifier to the lift station wet well for mixing with the raw sewage and to insure continuous flow through the plant. The overflow from the final clarifier flows by gravity through six oxidation ponds in series and is then discharged into a tributary of Deep Creek. No chlorination of the effluent prior to discharge is practiced. The settled solids from the primary clarifier are pumped to an anaerobic digestor, and the digested sludge is periodically drained to sludge drying beds. The dried sludge is given to local residents for use as fertilizer. Supernatant from the digestor and the filtrate collected beneath the sludge drying beds is returned to the lift station wet well. An emergency bypass line to a holding pond is available, but there is no facility for later returning bypassed sewage from the holding pond to the treatment plant.

The stated design capacity of the plant is 2.0 mgd. It is estimated that the plant serves about 12,000 persons and reportedly receives an average flow of about 1.3 mgd. The monthly flow and BOD permitted by the TWQB are 2.0 mgd and 20 ppm respectively, with no restrictions on TSS. Available sampling data published by the Texas State Department of Health and Texas Water Quality Board are as follows:

Influent - Effluent Data (mg/l)

| | TSDH (1/72) | TWQB (1/72) |
|---|---|---|
| Raw BOD | 180 | 175 |
| Raw TSS | 170 | 167 |
| Final BOD | 20 | 20 |
| Final TSS | 41 | 41 |

Generally, the plant has been well operated and maintained. The City owns about 120 acres of land, of which 25 acres is occupied by the existing sewage treatment plant. An additional 25 acres are available that could possibly be used for expansion of existing facilities and about 400 acres of farmland adjacent to the plant site could be utilized for irrigation. In the past, adjacent landowners have irrigated with water from Deep Creek below the plant site primarily during the March through August growing seasons. During these summer months, the stream flow is largely composed of effluent from the treatment plant. At the present time, nearby Western Texas College plans to construct facilities which will pump effluent from the treatment plant to holding ponds and subsequently utilize the wastewater for irrigation of a golf course. It is anticipated that this reuse will not exceed an average of 0.5 mgd.

The City owns and operates a water treatment plant located in the south-central sector of the City near the intersection of 33rd Street and the Roscoe, Snyder, and Pacific Railroad. The wastewater produced by the plant consists of treatment chemicals, sediments, and backwash water and is discharged to a tributary of Deep Creek. To eliminate this waste source, it is suggested the City either construct holding facilities for retention and evaporation of all waste or discharge into the sanitary collection system.

There is no significant industrial or agricultural wastewater produced within the corporate limits of Snyder nor are any anticipated in the future. However, a 10,000-head cattle feedlot which is located about 2 miles southeast of the intersection of U.S. 180 and U.S. 84 and adjacent to U.S. 84 on the south has a permit to dispose of runoff from the feedlot in retention ponds with a minimum capacity of 32.3 acre-feet. The ponds are to be dewatered by evaporation and by irrigation of at least 130 acres of farmland. Solid wastes are to be utilized as a soil amendment and fertilizer by local farmers. No discharge is permitted by the TWQB *except during occasions of rainfall amounts in excess of 6 inches* in a 24-hour period when a discharge may be made to a tributary of Deep Creek.

The existing collection system appears adequate to carry existing flows and serves nearly all of the significant development in the area. Minor extensions of service to existing residential areas west and northwest of the City, as shown on Plate WCT-12, are recommended and are estimated to cost about $156,000, including engineering and contingencies. In addition, future residential development is anticipated in the southwest sector of the City in the vicinity of Western Texas College and Cogdell Memorial Hospital. The future mains and lift stations needed to serve this development when it occurs are shown on Plate WCT-12 and are estimated to cost $240,000, including engineering and contingencies.

The existing sewage treatment plant is 23 years old and appears to have been well operated and maintained. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of this law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by a treatment process such as employed by Snyder, and the City will be required to implement a higher level of waste treatment prior to 1977. As an alternative to costly acceptable secondary facilities or partial tertiary facilities which would produce an acceptable secondary effluent by 1977, it is recommended the City supplement the treatment level by initiating total irrigation of all effluent such that no discharge is made to Deep Creek. Addition of total irrigation will satisfy the requirements of PL 92-500 throughout the planning period, since total irrigation will satisfy the requirement for best practicable treatment by 1983 if performed in manner which is in conformance with current standards. It is recommended the City enter

into a contractual agreement with Western Texas College and adjacent landowners for the irrigation of all effluent from the plant with the College and landowners supplying the necessary pumpage, irrigation equipment, and additional holding ponds needed to store the effluent during non-irrigable periods. The existing oxidation ponds should also be utilized for holding ponds. In accordance with current TWQB recommendations, the effluent applied to the College golf course should have a chlorine residual of 5 ppm. The City has the alternative of owning its own irrigation system. This alternative would require the City to acquire the necessary land and irrigation facilities. If, by 1977, the City irrigated 100 percent of the effluent, capital costs of the land and 18-acre holding pond, irrigation equipment, and engineering and contingencies are estimated to be $330,000.

The associated additional annual operation and maintenance costs are estimated to be about $26,000. The costs would be somewhat less if Western Texas College utilized some of the effluent for irrigation.

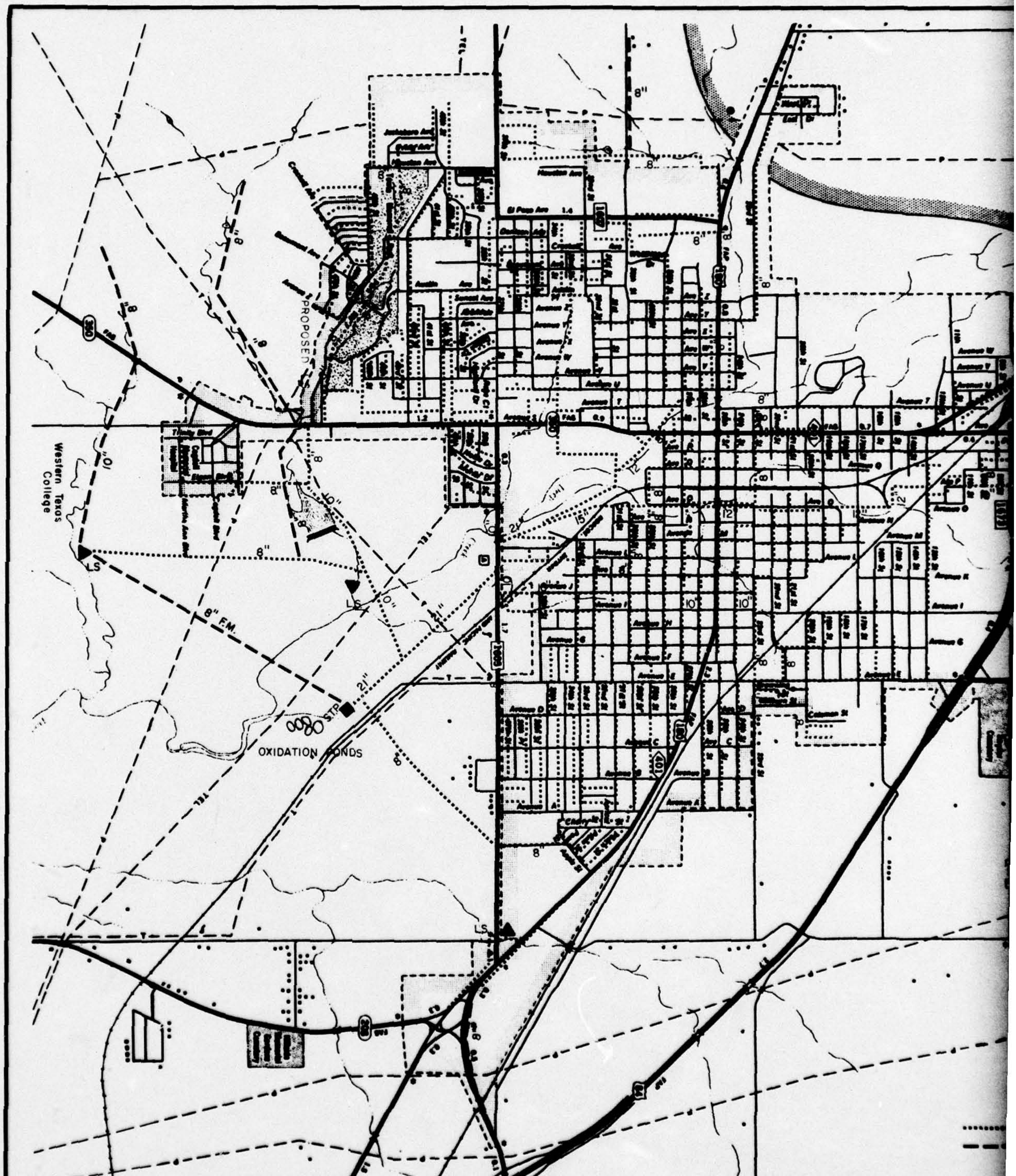
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. *However, should the* City of Snyder wish to implement a discharge plan, the following items would be required.

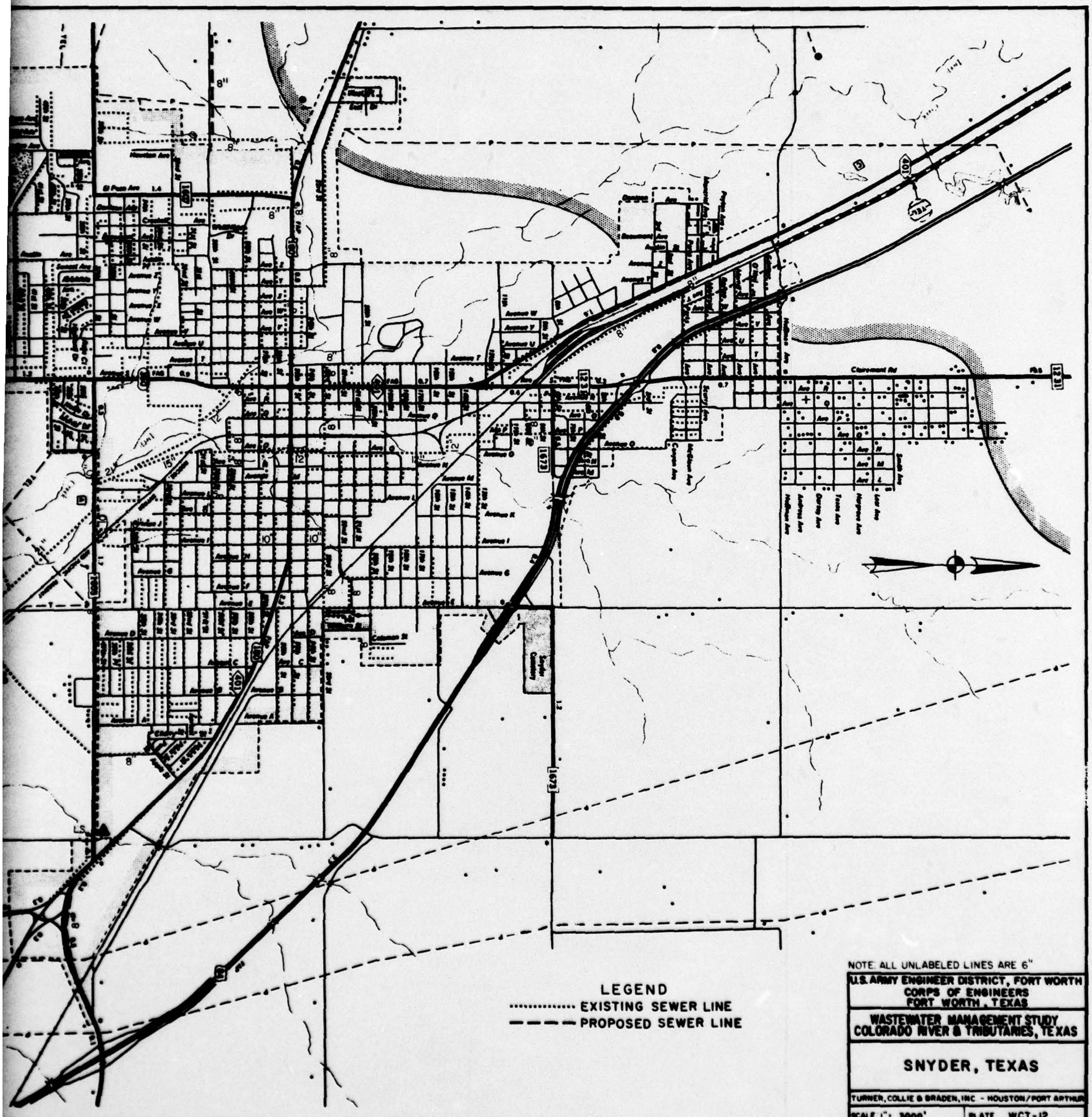
1. By 1977, construct a 1.0-mgd conventional secondary treatment facility of the activated-sludge type at an approximate capital cost of $729,000, including engineering and contingencies, with an annual operation and maintenance cost of $46,000.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $273,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $220,000, including engineering and contingencies.

In conclusion, the most practical and economical method to meet the requirements of the laws would be to irrigate with all effluent. Irrigation would eliminate any adverse impacts that may be associated with the present discharge. Irrigation will provide for a most valuable and economical reuse of the effluent in a seasonally semi-arid area. In addition to eliminating discharge of effluent to Deep Creek, irrigation will assist in the production of quality crops of grasses and small grains from the irrigated land.


Western Texas College
PROPOSED
LS
8" F.M.
STP
21"
OXIDATION PONDS


LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: ALL UNLABELED LINES ARE 6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
SNYDER, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE 1" = 3000'
PLATE WCT-12
Claremont Rd
L.S.

2

## SMALL COMMUNITIES WITHOUT MUNICIPAL SEWERAGE FACILITIES

The purpose of this sub-section is to present a general description and to discuss the sewage treatment needs of ten small communities which presently do not have municipal sewerage facilities. These communities are located within the jurisdiction of the West Central Texas Council of Governments and had a 1970 population of at least 200 persons. The communities and the counties within which they are located are listed in the following table. This table also gives the present and anticipated population for each community as projected by the TWDB and indicates the incorporation status of the communities. With the exception of the three communities in Brown County which are projected to have a slight growth, the communities are all projected to lose significant population by 2020.

TABLE WCT-6

Population Projections

| | | 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|
| Brown Co. | Blanket* | 346 | 350 | 360 | 370 |
| | May* | 300 | 300 | 310 | 320 |
| | Zephyr | 205 | 200 | 210 | 220 |
| Mitchell Co. | Westbrook* | 298 | 250 | 210 | 110 |
| Nolan Co. | Blackwell* | 279 | 230 | 220 | 170 |
| Runnels Co. | Rowena | 446 | 360 | 280 | 120 |
| Scurry Co. | Hermleigh | 711 | 610 | 540 | 360 |
| | Ira | 464 | 390 | 350 | 230 |
| Taylor Co. | Lawn* | 344 | 320 | 310 | 260 |
| | Tuscola* | 497 | 470 | 450 | 380 |

It should be noted that an apparent discrepancy exists between the population given in Table WCT-6 for Hermleigh and the population indicated by the number of existing water system connections. Water system data furnished by the Texas State Department of Health indicate 115 water connections and an estimated population served of about 400 for Hermleigh. The population estimate of 400 is in agreement with that observed in the field; therefore, it is believed that the population figure for Hermleigh given in Table WCT-6 includes persons living in scattered residences or on farms in the vicinity of Hermleigh.

Table WCT-7 presents a brief soils description for each community indicating the soil type, permeability, and limitations to septic tanks and sewage lagoons. A general description of the topography and drainage of each community is given in Table WCT-8.

Land usage for each of the communities, generally typical of that found in other small towns, is characterized by scattered residential development and a few commercial and public facilities, mostly located along major streets in the central areas of the communities. The economics are primarily based on agriculture with no known contribution from industry. Anticipated growth potential for these communities is very slight due to a lack of adequate economic activity or resource availability.

The projected water use for the communities, a reflection of the population trend, has been projected by the TWDB as presented in Table WCT-9. Also given in this table are the sources of water supply for each community. Table WCT-10 presents the municipal waste loads for the communities as projected by the TWQB.

All of the communities listed herein utilize private septic tanks for the treatment and disposal of domestic sewage. Very little information was available during the course of this study which would indicate the existing condition of these private facilities or whether local problems might exist as a result of the utilization of septic tanks for wastewater disposal. A review of available maps of the communities was made to check the approximate number and density of the residences in the community. This review indicated that all these communities have a very light density of development.

Table WCT-7 indicates that six of the communities are underlain with soils which are classified by the Soil Conservation Service as having severe limitations to septic tanks due to the low permeability. However, this does not necessarily mean that septic tanks will not work in this type of soil. Factors such as length of the tile field, residential density, and amount of gravel placed around the drain tile will certainly affect the performance of septic tank treatment and effluent disposal by tile field in these areas. A recommendation that the septic tanks be abandoned and replaced by a municipal sewage collection and treatment system based on these generalized soil limitations alone cannot be made, especially since these communities are small and thus would incur a high monthly cost per connection if they constructed a conventional sewage collection and treatment system. Therefore, no new sewage facilities are proposed for these communities and no corresponding exhibits of the communities are included herein.

## TABLE WCT-7

## SOILS CHARACTERISTICS

| COUNTY | TOWN | SOIL ASSOCIATION | PERMEABILITY (IN/HR) | LIMITATIONS TO SEPTIC TANKS | LIMITATIONS TO SEWAGE LAGOONS |
|---|---|---|---|---|---|
| BROWN | Blanket | Menard – Brackett | 0.20 – 0.63 | Severe: Depth, Perm. | Moderate: Depth |
| | May | Menard – Brackett | 0.20 – 0.63 | Severe: Depth, Perm. | Moderate: Depth |
| | Zephyr | Bolar – Tarrant | 0.20 – 0.63 | Severe: Depth, Perm. | Moderate: Depth |
| MITCHELL | Westbrook | Cobb – Miles | 2.00 – 6.30 | Moderate: Depth | Moderate: Depth |
| NOLAN | Blackwell | Mansker – Potter | 0.60 – 2.00 | Severe: Depth | Severe: Depth |
| RUNNELS | Rowena | Rowena – Tobosa | 0.60 – 2.00 | Moderate: Perm. | None |
| SCURRY | Hermleigh | Abilene | 0.20 – 0.63 | Severe: Perm. | Slight |
| | Ira | Cobb – Miles | 2.00 – 6.30 | Moderate: Perm. | Moderate: Perm. |
| TAYLOR | Lawn | Abilene – Wichita | 0.20 – 0.63 | Severe: Perm. | Slight |
| | Tuscola | Abilene – Wichita | 0.20 – 0.63 | Severe: Perm. | Slight |

## TABLE WCT-8

## TOPOGRAPHICAL AND DRAINAGE DESCRIPTIONS

| COUNTY | TOWN | TOPOGRAPHY | DRAINAGE |
|---|---|---|---|
| BROWN | Blanket | Gently sloping | South by tributary of Blanket Creek |
| | May | Nearly flat | West by tributaries of Hog Creek |
| | Zephyr | Nearly flat to gently sloping | South by tributaries of Big Blanket Creek |
| MITCHELL | Westbrook | Nearly flat, near drainage divide | Southeast by tributary of Sulphur Creek |
| NOLAN | Blackwell | Nearly flat | Northwest by tributaries of Oak Creek |
| RUNNELS | Rowena | Nearly flat | North by tributaries of Rock Creek |
| SCURRY | Hermleigh | Nearly flat, near drainage divide | West by tributary of Sulphur Creek |
| | Ira | Gently sloping | East by tributary of Canyon Creek |
| TAYLOR | Lawn | Nearly flat to gently sloping | South by Jim Ned and Red Bank Creeks |
| | Tuscola | Nearly flat | South by Jim Ned Creek |

# TABLE WCT-9

## MUNICIPAL WATER SUPPLY DATA

| UNTY | TOWN | WATER USAGE RATE (MGD) 1970 | 1980 | 1990 | 2020 | SOURCE OF WATER SUPPLY |
|---|---|---|---|---|---|---|
| ROWN | Blanket | .037 | .038 | .046 | .054 | Three wells |
| | May | .032 | .033 | .040 | .047 | One well |
| | Zephyr | .022 | .022 | .027 | .032 | Treated water from Brown Co. WID No. 1 |
| MITCHELL | Westbrook | .022 | .019 | .016 | .008 | Treated water from Colorado City |
| NOLAN | Blackwell | .031 | .032 | .031 | .022 | Oak Creek Reservoir |
| RUNNELS | Rowena | .036 | .032 | .026 | .012 | Treated water from Ballinger |
| SCURRY | Hermleigh | .059 | .062 | .057 | .043 | Three wells |
| | Ira | .038 | .039 | .037 | .027 | Treated water from Snyder |
| TAYLOR | Lawn | .037 | .038 | .037 | .034 | Lake Coleman |
| | Tuscola | .054 | .055 | .054 | .049 | Two wells |

# TABLE WCT-10

## MUNICIPAL WASTE LOAD PROJECTIONS

| COUNTY | TOWN | FLOW (MGD) 1970 | 1980 | 1990 | 2020 | BOD (ppd) 1970 | 1980 | 1990 | 2020 | TSS (ppd) 1970 | 1980 | 1990 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BROWN | Blanket | .029 | .030 | .031 | .031 | 59 | 63 | 65 | 70 | 69 | 74 | 79 | 85 |
| | May | .026 | .026 | .026 | .027 | 51 | 54 | 56 | 61 | 60 | 63 | 68 | 74 |
| | Zephyr | .017 | .017 | .018 | .019 | 35 | 36 | 38 | 42 | 41 | 42 | 46 | 51 |
| MITCHELL | Westbrook | .025 | .021 | .018 | .009 | 51 | 45 | 38 | 21 | 60 | 52 | 46 | 25 |
| NOLAN | Blackwell | .024 | .020 | .019 | .014 | 47 | 41 | 40 | 32 | 56 | 48 | 48 | 39 |
| RUNNELS | Rowena | .038 | .031 | .024 | .010 | 76 | 65 | 50 | 23 | 89 | 76 | 62 | 28 |
| SCURRY | Hermleigh | .060 | .052 | .046 | .031 | 121 | 110 | 97 | 68 | 142 | 128 | 119 | 83 |
| | Ira | .039 | .033 | .030 | .020 | 79 | 70 | 63 | 44 | 93 | 82 | 77 | 53 |
| TAYLOR | Lawn | .029 | .027 | .026 | .022 | 58 | 58 | 56 | 49 | 69 | 67 | 68 | 60 |
| | Tuscola | .042 | .040 | .038 | .032 | 84 | 85 | 81 | 72 | 99 | 99 | 99 | 87 |

It should be noted that it is highly unlikely that these septic tank systems will be a source of significant pollution of the Colorado River or its major tributaries, since the volume of wastewater is quite insignificant in comparison to that produced by the larger cities. Also, septic tanks tile fields are, in effect, a type of land disposal, which is an acceptable method of effluent disposal.

If any problem with septic tanks does exist in any of these communities, the problem would most likely be one of effluent ponding or septic tank overflow due to exceeding the assimilative capacity of the soil.

These problems would mainly affect local health conditions and cause localized pollution. Should these problems occur in any of these communities in such severity as to require abandonment of this means of disposal, either presently or in the future, it is recommended that the septic tanks be replaced by a conventional collection and treatment system which will meet the requirements of the current laws and regulations.

In summary, therefore, no municipal sewage collection and treatment facilities are recommended for any of these communities unless an absolute need to replace the private septic tanks with such a system is demonstrated in the future.